United States
Department of
Agriculture

Forest Service

Northeastern Forest
Experiment Station

Research Attainment Report

Fiscal Year 1995

Abstract

This report contains information on research attainment during fiscal year 1995 at the Northeastern Forest Experiment Station of the USDA Forest Service. Data presented include the funding and staffing for each problem, a narrative summary of the attainment in each problem, and a bibliography of all publications resulting from this research.

KEYWORDS: Research, attainment, research management

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Research Attainment Report Fiscal Year 1995

United States Department of Agriculture
Forest Service
Northeastern Forest Experiment Station

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Preface

This attainment report serves as one basis on which to evaluate USDA Forest Service research programs and work unit performance. It also provides information required by the Congress, the Department of Agriculture, and the Office of Management and Budget for their use in evaluating Forest Service research progress. This report for the Northeastern Forest Experiment Station will be aggregated with reports from other Forest Experiment stations to prepare a national report on research programs and accomplishments.

The basis for this report is the Research Work Unit Description (RWUD) for each work unit. The RWUD defines each unit's mission and problems to be studied to accomplish that mission. The approach to detailed investigation of each problem is described in a problem analysis. The problem analysis serves as a basis for preparing a series of study plans, each contributing to the problem solution, and ultimately, to accomplishment of the work unit mission.

Introduction

The Research Work Unit Attainment Reports in Part I each begin with a Research Work Unit Summary. This summary is in the form of a table, listing the problem number and title, the functional account funding the problem, the current level of funding, the current staffing (scientist years) and a tally of the number of publications produced, whether in the work unit, through extramural research, or through cooperative research.

The Research Work Unit Summary is followed by further information for each problem giving the attainments for a single problem. These reports give bibliographic information on each publication resulting from the research on a particular problem, plus a narrative summary of the attainment for that problem.

Part II is a bibliography of all the publications produced as a result of research conducted by the Northeastern Forest Experiment Station in Fiscal Year 1995, listed in alphabetical order by author under the proper functional account.

Part I: Research Work Unit Attainment Reports

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4103

The Role of Environmental Stress on Tree Growth and Development

Tyree, Melvin T., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Better define and measure state of tree health in order to identify significant stress events	FMR	92	.7		2	2
2. Understanding water-stress physiology: hydraulic sufficiency of stem to conduct water to leaves	FMR	551	2.0	5		2
3. Physiological changes associated with acidic leaching of soil and leaf nutrients	FMR	107	.7	1		
4. Knowledge of tree chemistry and physiology needed to understand effects of winter	FMR	157	1.0	3		1

Problem 1 **Better define and measure state of tree health in order to identify significant stress events**
FY 95 Research Attainments

Publications

Cooperative

Wilmot, Timothy R.; Ellsworth, David S.; Tyree, Melvin T. 1995. Relationships among crown condition, growth, and stand nutrition in seven northern Vermont sugarbushes. Canadian Journal of Forest Research. 25: 386-397.

Zahka, G.A.; Baggett, K.L.; Wong, B.L. 1995. Inoculum potential and other VAM fungi parameters in four sugar maple forests with different levels of stand dieback. Forest Ecology and Management. 75: 123-134.

Extramural

Ellsworth, David S.; Liu, Xuan. 1994. Photosynthesis and canopy nutrition of four sugar maple forests on acid soils in northern Vermont. Canadian Journal of Forest Research. 24: 2118-2127.

Liu, Xuan. 1995. Physiological performance of sugar maple (Acer saccharum Marsh.) in two stands with contracting health conditions in northwestern Vermont. Burlington, VT: University of Vermont. 182. Ph.D. dissertation.

Attainment

Soil, leaf and stem samples collected annually for 5 years have confirmed that declining maples are nutrient deficient in Ca (and sometimes K & Mg) and also are growing on soils with low pH. Response to fertilizer amendments on subplots have been monitored for the fifth year. A Ph.D. student (Xuan Liu) has completed her dissertation on physiological responses of sugar maple on healthy and declining sites and two publications on the effect of nutrient stress on photosynthesis and root growth. In a separate study no effect of insect feeding damage on sugar maple on water use efficiency was found but there may be reduced leaf CO2 assimilation rate as a result of direct tissue damage or reduced stomatal conductance.

The amounts and kinds of sugars present in sugar maple during the leafless period when there is dependence on stored food reserves could reflect changes in metabolic activities that may provide information on the state of tree health. Quantification of the major sugars and relationships among the individual sugars have been completed while the identity of less common sugars remains to be processed. A paper was submitted and accepted on the possibility of using VAM fungi colonization levels, especially those of arbuscules in sugar maple feeder roots, as predictors of future decline in sugar maple health. The information obtained indicated that the site with the greatest crown dieback had the lower viable propaqule density and the lower VAM fungi colonization level in maple feeder roots.

Problem 2 **Understanding water-stress physiology: hydraulic sufficiency of stem to conduct water to leaves**
FY 95 Research Attainments

Publications

Research Unit

Tabor, Christopher A.; Brett, Philip W. 1995. Hydraulic architecture of woody plants within the northern forest ecosystem. In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 14. Abstract.

Tabor, Christopher A.; Carlo, Andrew S.; Schaberg, Paul G.; Wilkinson, Ronald C.; Brett, Philip W. 1995. Comparisons of the hydraulic architecture of low- and high-elevation balsam fir. In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 15. Abstract.

Tabor, Christopher A.; Schaberg, Paul G.; Wilkinson, Ronald C.; Brett, Philip W. 1995. Comparative hydraulic architecture of low- and high-elevation balsam fir from field and common garden sources. Supplement to Plant Physiology. 108 (2): 109.

(Abstracts of pages and posters from the 1995 annual meeting of the American Society of Plant Physiologists, July 29-August 2, Charlotte, NC.)

Tyree, Melvin T.; Davis, Stephen D.; Cochard, Herve. 1994. Biophysical perspectives of xylem evolution: is there a tradeoff of hydraulic efficiency for vulnerability to dysfunction? IAWA Journal. 15 (4): 335-360.

Tyree, Melvin T.; Patino, Sandra; Bennink, John; Alexander, John. 1995. Dynamic measurements of root hydraulic conductance using a high-pressure flowmeter in the laboratory and field. Journal of Experimental Botany. 46 (282): 83-94.

Cooperative

Lewis, Ann M.; Harnden, Virginia D.; Tyree, Melvin T. 1994. Collapse of water-stress emboli in the trachieds of Thuja occidentalis L. Plant Physiology. 106: 1639-1646.

Patino, Sandra; Tyree, Melvin T.; Herre, E. Allen. 1995. Comparison of hydraulic architecture of woody plants of differing phylogeny and growth form with special reference to free-standing and hemi-epiphytic Ficus species from Panama. New Phytologist. 129: 125-134.

Attainment

The technology for the new high pressure flowmeter (HPFM) has been transferred to Dynamax Inc., Houston, TX, and an initial production run of 6 units is expected in late 1995 after some design improvements are tested. The commercialization of the HPFM will make it easier for other scientists to use the technology. The HPFM has been used in Panama to compare roots and shoots of various tree seedlings. We have found big differences in the biomass cost of root conductance, root surface area and root length between species. Pioneer species tend to have more roots and higher root conductance per unit biomass invested than shade-tolerant old-forest species. We have also completed studies on the water relations of two more tropical species: an epiphyte and a swamp tree. Manuscripts have been submitted to peer reviewed journals. Studies on the mechanism of sap flow in maple have confirmed a role of osmosis in sap exudation. Using the HPFM we have been able to decouple the sap uptake and exudation processes which normally requires freezing to initiate the sap uptake and a thaw to initiate exudation. Studies of lead contamination have revealed that the maple tree is not the source. The main source is the evaporator, but a number of lesser sources were also found. We have also experimented with ways of removing lead from the finished product. Studies on the hydraulic architecture of temperate trees have been expanded to include additional species and measurements of physiological parameters that will enable us to more clearly define the dynamic interrelationships among woody plants within Vermont forests.

Problem 3 **Physiological changes associated with acidic leaching of soil and leaf nutrients**
FY 95 Research Attainments

Publications

Research Unit

Baggett, K.L.; Zahka, G.A.; Wong, B.L. 1995. Vesicular-arbuscular mycorrhizae are bioindicators of maple decline. In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 11. Abstract.

Attainment

Experimental treatments and analytical portions of a study on the affect of acidity and different metals on the mineral content and mitochondrial respiration of M and NM pine seedlings and its associated mycorrhizal fungus have been completed. Data analysis and interpretation for 2 manuscripts is in progress. A manuscript is completed on Aluminum and pH affects nutrient content and mitochondrial function of mycorrhizal and non-mycorrhizal loblolly pine.

Problem 4 **Knowledge of tree chemistry and physiology needed to understand effects of winter**
FY 95 Research Attainments

Publications

Research Unit

Alexander, John D.; Donnelly, John R.; Shane, John B. 1995. Photosynthetic and transpirational responses of red spruce understory trees to light and temperature. Tree Physiology. 15: 393-398.

Schaberg, P.G.; Wilkinson, R.C.; Shane, J.B.; Donnelly, J.R.; Cali, P.F. 1995. Winter photosynthesis of red spruce from three Vermont seed sources. Tree Physiology. 15: 345-350.

Schaberg, Paul G.; Shane, John B.; Cali, Paula F. 1995. Cold-season photosynthesis: an "evergreen advantage"? In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 12. Abstract.

Cooperative

Hawley, G.J.; Schaberg, P.G.; DeHayes, D.H.; Cumming, J.R.; Strimbeck, G.R.; Borer, C.H. 1995. A mechanism for acid mist-induced freezing stress of red spruce? In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 13. Abstract.

Attainment

A comprehensive evaluation of changes in gas exchange and cold hardiness of red spruce during a simulated winter thaw showed that increases in respiration and photosynthesis can occur within 48 hours of thaw inception and that reductions in cold tolerance can be great (up to 14 degrees C) but are delayed relative to other changes in physiology. A field study of photosynthetic capacity and cold hardiness levels of mature red spruce during an extreme natural thaw provided support for results from the simulation study and indicated that montane trees can experience significant changes in photosynthetic capacity and hardiness during winter. Manuscripts describing these studies were recently submitted to journals for publication. Studies of the possible role foliar sugars play in controlling photosynthetic capacity during winter were also initiated. Preliminary results suggest that high sucrose availability during winter decreases photosynthetic capacity, possibly through feedback inhibition of biochemcial pathways. A manuscript combining results from these preliminary experiments with field measurements of seasonal changes in photosynthetic capacity has been initiated. In addition, a study of the impact of acid misting on foliar calcium leaching and needle cold tolerance was completed. Two manuscripts are in preparation for this study; one describing research results and the second outlining the use of a new protocol developed for the visualization and relative quantification of membrane calcium using a fluorescent probe.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4104

Methods for Measurement, Analysis, and Modeling of Forest Growth and Structure

Solomon, Dale S., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Traditional methods are inadequate for modeling effects of environmental changes on forest trees	FMR	160	2.0	1	4	
2. Present growth predictions inadequate and lack mgmt. strategies, responsive to envir. changes	FMR	160	2.0	5		

Problem 1 **Traditional methods are inadequate for modeling effects of environmental changes on forest trees**
FY 95 Research Attainments

Publications

Research Unit

Valentine, Harry T.; Ludlow, Anthony R.; Furnival, George M. 1994. Modeling crown rise in even-aged stands of Sitka spruce or loblolly pine. Forest Ecology and Management. 69: 189-197.

Extramural

Gregoire, Timothy G.; Valentine, Harry T.; Furnival, George M. 1995. Sampling methods to estimate foliage and other characteristics of individual trees. Ecology. 76 (4): 1181-1194.

Kelliher, F.M.; Hollinger, D.Y.; Schulze, E-D.; Vygodskaya, N.N.; Byers, J.N.; Hunt, J.E. 1994. Evaporation from an eastern Siberian larch forest. In: Proceedings of the international symposium on forest hydrology; 1994 October; Tokyo, Japan. Tokyo, Japan: Institute of Forest Hydrology: 123-130.

Schulze, E-D.; Schulze, W.; Kelliher, F.M.; Vygodskaya, N.N.; Ziegler, W.; Hollinger, D.Y. 1995. Aboveground biomass and nitrogen nutrition in a chronosequence of pristine Dahurian larix stands in eastern Siberia. Canadian Journal of Forest Research. 25: 943-960.

Teskey, Robert O.; Sheriff, David W.; Hollinger, David Y.; Thomas, Richard B. 1995. External and internal factors regulating photosynthesis. In: Smith, W.K.; Huckler, T.M., comps., eds. Resource physiology of conifers. New York, NY: Academic Press: 105-140.

Attainment

Factors regulating forest carbon dioxide uptake and loss were studied at a site in Howland, Maine with researchers from the University of Maine, the Woods Hole Research Center, and Cornell University. Preliminary results suggest that the evergreen trees were functioning (carrying out photosynthetic carbon uptake) immediately following springtime thawing of the soil, well before a deciduous forest for the south. External funding was procured from the NSF and DOE and will allow the Forest Service to expand the research at Howland and additional sites.

A stand-level carbon-balance model Pipestem was completed with the collaboration of scientists at Virginia Tech. Pipestems provides a mechanistic description of temporal changes in the carbon balance, production and loss of dry matter, and dimensions of an even-aged monoculture. The model furnishes estimates of: the rate of production of photosynthate; the rates of dry-matter production, constructive respiration, and maintenance respiration of foliage, feeder roots, and live wood; the rates of loss of dry matter due to foliage and feeder-root turnover; and the rates of loss of woody dry matter to self-pruning and self-thinning. Linkages with steady-state physiological process models to provide a means to gauge the effects of weather and other environmental factors on stand dynamics. Analyses of the model indicates that rates of production and loss of dry matter become more sensitive to environmental influences as a stand ages and the consumption of carbon substrate for maintenance respiration increases.

Problem 2 **Present growth predictions inadequate and lack mgmt. strategies, responsive to envir. changes**
FY 95 Research Attainments

Publications

Research Unit

Gove, Jeffrey H. 1994. Geostatistical modeling of tree crown shape. In: Rennolls, Keith, ed. Stochastic spatial models in forestry: proceedings of a IUFRO S4.11 conference; 1993 May 18-21; Thessaloniki, Greece. Greenwich, UK: University of Greenwich: 7-17.

Gove, Jeffrey H.; Fairweather, Stephen E.; Solomon, Dale S. 1994. Optimizing the horizontal structural diversity in uneven-aged northern hardwood stands. Environmental and Ecological Statistics. 1: 109-120.

Gove, Jeffrey H.; Linder, Ernst; Tzilkowski, Walter M. 1995. Some results on the combined removal and signs-of-activities estimators for sampling closed animal populations. Gen. Tech. Rep. NE-199. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 34.

Gove, Jeffrey H.; Patil, Ganapati P.; Taillie, Charles. 1995. A mathematical programming model for maintaining structural diversity in uneven-aged forest stands with implications to other formulations. Ecological Modelling. 79: 11-19.

Solomon, Dale S.; Herman, David A.; Leak, William B. 1995. FIBER 3.0: an ecological growth model for northeastern forest types. Gen. Tech. Rep. NE-204. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 24.

Attainment

Sampling of wildlife habitats has focused on how to best combine data from animal populations based on removing individuals in combination with measurements of their signs-of-activities. Simulation experiments showed the problems associated with estimators when some assumptions are in violation and present remedial measures. Comprehensive computer programs developed for the analysis of individual experiments, or the simulation of multiple experiments explain procedures for these techniques. A new approach for the characterization of tree crown shape was constructed using geostatistical techniques. Variography and kriging allow both the ability of modeling spatial variability within a tree crown, and the estimation of crown shape with its associated volume or surface area measures. Optimal management models now allow forest resource managers a method for the estimating of diameter distributions within forest stands to either preserve or maximize the horizontal structural diversity within the stand.

A handbook describing the use and application of the ecological base model FIBER has been completed. FIBER allows resource managers to use silviculture tools constructed from growth studies, as a means of simulating forest stands through successional stages. The expansion of FIBER allows for monitoring of the ecological integrity of the New England forest ecosystems.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4151

Ecology and Management of Northern Conifer and Associated Ecosystems
Brissette, John C., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Long-term effects of silvicultural options on habitat diversity, stand structure, and yields	FMR	338	.9	1		
2. Developing information about the ecophysiology of northern conifer seedling establishment	FMR	60	.1			

Problem 1 **Long-term effects of silvicultural options on habitat diversity, stand structure, and yields**
FY 95 Research Attainments

Publications

Research Unit

Northeastern Station. 1995. Publications of the Northeastern Forest Experiment Station: 1991 and 1992. Gen. Tech. Rep. NE-210. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 61.

(This publication relates to the Research Work Units in the Station, but due to requirements of the RAR software, it needed to be associated with a particular unit. This unit was chosen at random.)

Attainment

Installation of two new silvicultural treatments, extended shelterwood and crop tree management, was completed with post-harvest inventories of the new compartments. In addition to the inventories in the new treatments, scheduled inventories in four other compartments in the long-term silviculture study were completed, as were inventories in the Management Intensity Demonstration area. Also, a study on the effects of pre-commercial thinning was measured to obtain 18-year results. These study areas and results from the long-term silvicultural experiment were shown to over 300 people from 12 professional and public organizations. An economic analysis of timber production was initiated in cooperation with NE-4154. New research was also generated with graduate studies in cooperation with the University of Maine. One student is in a Cooperative Education position with NE-4151 and her research focuses on growth and structure in northern conifer stands managed under selection silviculture. Another study is investigating stand development at about 15 years after overstory removal in a shelterwood treatment. Additional graduate research utilizing this long-term experiment include studying the impacts of a range of silvicultural options on bird and arthropod diversity and productivity. Two posters describing some regeneration results from this long-term study were presented at one regional and two international scientific and professional meetings.

Problem 2 **Developing information about the ecophysiology of northern conifer seedling establishment**
FY 95 Research Attainments

Publications

none

Attainment

Funds from a competitive program were awarded to NE-4151 for a cooperative study that is investigating the dynamics between two pine species where their respective geographic ranges meet with relatively little overlap. The component of this interdisciplinary research just initiated by NE-4151 compares and contrasts the ecophysiology of seedling establishment between the species. In a separate study, a post-doctoral scientist was hired to explore the relationship between red spruce regeneration and forest floor and understory vegetation. This research is being conducted at a number of locations throughout Maine, including our long-term study under Problem 1.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4152

Silvicultural Decision Systems for Eastern Hardwood Forests of the Mid-Atlantic Region

Stout, Susan L., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. How to control species composition during regeneration for a variety of objectives	FMR	565	1.6	3		
2. Regulate stand growth and development to maximize multiple-use benefits from existing stands	FMR	229	.8	17		2
3. Effects of silvicultural practices on wildlife habitat, aesthetics, and on diversity	FMR	183	1.2	5	1	
4. Consolidate the vast array of multiple resource knowledge into a computer-based decision tool	FMR	46	.4	2		1

Problem 1 **How to control species composition during regeneration for a variety of objectives**
FY 95 Research Attainments

Publications

Research Unit

Horsley, Stephen B.; deCalesta, David S. 1995. Impact of white-tailed deer on a forest ecosystem: the Allegheny hardwood forest. In: Neal, J.D., ed. Proceedings of the 49th annual meeting of the Northeastern Weed Science Society; 1995 January 2-5; Boston, MA. Ithaca, NY: Northeastern Weed Science Society: 143. Abstract.

Horsley, Stephen B. 1994. Regeneration success and plant species diversity of Allegheny hardwood stands after Roundup application and shelterwood cutting. Northern Journal of Applied Forestry. 11 (4): 109-116.

Horsley, Stephen B. 1995. Facilitation of plant-plant interference by herbivory in the Allegheny hardwood forest, Pennsylvania, USA: a vegetation management problem. In: Gaskin, E.R.; Zabkiewicz, J.A., comps. Popular summaries from 2nd international conference on forest vegetation management; 1995 March 20-24; Rotorua, NZ. FRI Bull. 192. Rotorua, NZ: New Zealand Forest Research Institute: 224-226.

Attainment

Overbrowsing by white-tailed deer in the forests of the Allegheny Plateau region of Pennsylvania limits the diversity of regeneration. Overbrowsing has been an important ecological factor since the 1930's. As a result, the diversity of both woody and herbaceous plant communities is frequently low. Research completed under this problem this year documents these effects in three new ways. First, research shows that where deer eliminate key shade-tolerant species such as eastern hemlock and sugar maple from advance regeneration, pin cherry, a fast-growing but short-lived species, may come to dominate harvested or disturbed areas. Second, research has documented the interaction between light and deer density: the response of several woody species to increased light levels observed at low deer density fails to occur at high deer density because of browsing impact. Third, where forest floor plant communities are low in diversity because of many years of over-browsing, herbicide applications to remove dominating plants that deer don't browse will actually increase the diversity of forest floor plant communities.

Problem 2 **Regulate stand growth and development to maximize multiple-use benefits from existing stands**
FY 95 Research Attainments

Publications

Research Unit

Ernst, Richard L. 1994. Development of a silvicultural prescription. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 129-162.

Ernst, Richard L. 1994. Distribution of cut. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 289-322.

Horsley, Stephen B.; Auchmoody, L.R.; Walters, Russell S. 1994. Regeneration principles and practices. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 205-246.

Marquis, David A. 1994. History and origin of Allegheny forests. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 5-40.

Marquis, David A. 1994. SILVAH computer analysis. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 163-204.

Marquis, David A. 1994. Summary. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 367-376.

Marquis, David A. 1994. Thinning principles and practices. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 247-288.

Marquis, David A.; Cochran, Roe S. 1994. Introduction. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 1-4.

Marquis, David A., ed. 1994. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 376.

Nowak, Christopher A. 1995. Individual tree-versus stand-level approaches to thinning: is it a choice of one or the other, or a combination of both? In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 399. Abstract.

Nowak, Christopher A.; Abrahamson, Lawrence P.; Raynal, Dudley J.; Leopold, Donald J. 1995. Selective vegetation management on powerline corridors in New York State: tree density and species composition changes from 1975 to 1991. In: Doucet, G. Jean; Seguin, Colette; Giguere, Michel, eds. Proceedings, 5th international symposium on environmental concerns in rights-of-way management; 1993 September 19-22; Montreal, PQ. Montreal, PQ: Hydro-Quebec: 153-158.

Redding, James C. 1994. Marking ratios and the SILVAH system. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 323-328.

Redding, James C. 1994. Stand examination procedures. In: Marquis, David A., Ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 41-78.

Stout, Susan; Nowak, Christopher A.; McGuinness, Barbara. 1995. The research perspective. Journal of Forestry. 93 (9): 16-17.

Stout, Susan L. 1994. Principles and practices of uneven-age management. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 329-366.

Stout, Susan L. 1994. Stand data summary and analysis. In: Marquis, David A., ed. Quantitative silviculture for hardwood forests of the Alleghenies. Gen. Tech. Rep. NE-183. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 79-128.

Stout, Susan L.; Nowak, Christopher A.; deCalesta, David S.; Schuler, Thomas M.; Jones, Stephen B.; McGill, David E. 1995. Hardwood crop planning relative density guidelines for eastern Ontario hardwood stands. Inf. Rep. 12. Kemptville, ON: Eastern Ontario Model Forest. 81.

Cooperative

Abrahamson, Lawrence P.; Nowak, Christopher A.; Charlton, Philip M.; Snyder, Philip G. 1995. Cost effectiveness of herbicide and non-herbicide vegetation management methods for electric utility rights-of-way in the Northeast: state of the art review. In: Doucet, G. Jean; Seguin, Colette; Giguere, Michel, eds. Proceedings, 5th international symposium on environmental concerns in rights-of-way management; 1993 September 19-22; Montreal, PQ. Montreal, PQ: Hydro-Quebec: 27-43.

McGill, David W.; Jones, Stephen B.; Nowak, Christopher A. 1995. Identification of canopy strata in hardwood stands. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 547. Abstract.

Attainment

We have made new progress on many fronts under this problem this year. We have begun to understand how differences in crown architecture affect the ways in which species respond to partial cuts. Allegheny hardwoods are highly stratified by species, and each species has a characteristic crown shape and responsiveness. Studies reported this year show new and effective methods for explaining the relationships among crown form, canopy stratification, and tree growth. We have also begun to close the gap between two widely-used thinning approaches, showing ways to integrate the crop tree with the area-wide, relative density approach to thinning. We have designed an approach for developing a measure of relative density for hardwood stands in eastern Ontario, and testing its applicability to stands managed for a transition to a balanced, uneven-age structure. We reviewed the literature concerning the relationship between relative density and wildlife habitat. Finally, we have collaborated in tests of the cost-effectiveness of vegetation management methods for rights-of-way.

Lectures from the Allegheny Hardwood Silviculture Training Sessions were published this year as a General Technical Report. This book documents the complete package of ecological principals, inventory and analysis procedures, and decisions support principals for silviculture to promote and regenerate high-value sawtimber stands on the Allegheny Plateau. The system described represents a comprehensive and objective, quantitatively-based approach to silvicultural decision-making.

Problem 3 **Effects of silvicultural practices on wildlife habitat, aesthetics, and on diversity**
FY 95 Research Attainments

Publications

Research Unit

DeCalesta, David S. 1995. Effect of white-tailed deer and silvicultural practices on herbs and shrubs in northern hardwood forests. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 318. Abstract.

DeCalesta, David S.; Witmer, Gary W. 1995. Elk. In: Hygnstrom, Scott E.; Timm, Robert M.; Larson, Gary E. Prevention and control of wildlife damage, volume II. [Place of publ. unknown]: [Publisher name unknown]: D41-D50.

Nowak, Christopher A.; deCalesta, David S. 1995. Stand structure and wildlife communities in true old-growth and managed 2nd-growth forests on the Allegheny Plateau in northwestern Pennsylvania. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 14. Abstract.

Redding, Jim. 1995. History of deer population trends and forest cutting on the Allegheny National Forest. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 214-224.

Stout, Susan L.; deCalesta, David S.; Horsley, Stephen B.; Nowak, Christopher A.; Redding, James C. 1995. Ecosystems management research in hardwood forests dominated by deer. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 577. Abstract.

Extramural

Hoffman, Robin E.; Palmer, James F. 1994. Validity of using photographs to simulate visible qualities of forest recreation environments. In: Vander Stoep, Gail A., comp., ed. Proceedings of the 1994 northeastern recreation research symposium; 1994 April 10-12; Saratoga Springs, NY. Gen. Tech. Rep. NE-198. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 83-89.

Attainment

Important progress has been made in understanding the cumulative effects of silvicultural practices on deer impact at the landscape level. This progress is apparent in a new synthesis of historic information concerning deer densities and forest management in the Allegheny Plateau region of Pennsylvania, and in the evolving concepts of "diversity carrying capacity" appropriate where deer are part of an ecosystem approach to forest management.

We are also increasing our understanding of habitat relationships to key stand development patterns. Research reported this year demonstrates a higher species richness and abundance of bird species in old-growth, with high densities of cavity trees. Amphibian species richness, like that of small mammals, was similar between old-growth and managed second growth. Abundance of amphibians was higher in old-growth, of small mammals in second growth. Dead wood volume, much higher in old-growth, was the main difference reported in vegetative communities.

We have collaborated in the assessment of slides to measure forest visual quality. This technique is widely used. An understanding of its strengths and limitations will help managers develop esthetics management guidelines.

Problem 4 **Consolidate the vast array of multiple resource knowledge into a computer-based decision tool**
FY 95 Research Attainments

Publications

Research Unit

Ristau, Todd E.; deCalesta, David S.; Horsley, Stephen B.; McCormick, Larry H. 1995. SP-INDEX: an automated DOS-based computer program for calculating diversity indices. In: Neal, J.C., ed. Proceedings of the 49th annual meeting of the Northeastern Weed Science Society; 1995 January 2-5; Boston, MA. Ithaca, NY: Northeastern Weed Science Society: 98. Abstract.

Ristau, Todd E.; deCalesta, David S.; Horsley, Stephen B.; McCormick, Larry H. 1995. Calculating diversity indices using SP-INDEX, a program for IBM compatible microcomputers. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 227. Abstract.

Cooperative

Rauscher, H.M.; Twery, M.; Palmer, J.; Hoffman, R.; Steinman, J.; Kollasch, P. 1995. Northeast Decision Model design document. AI Applications. 9 (3): 85-86.

(Includes electronic insert (2 disks).)

Attainment

The following reflects major accomplishments for the life of this problem, which is officially being transferred to the NED Decision Model Development Team in Burllington, VT: Guidelines and a framework have been developed for integrating multiple-resource criteria into a decision support framework. Support has been for the development of NED-SIPS and the Stewardship Planning Guide (see attainments of NE-4454 and NE-4507). In our unit this year, lectures from the Allegheny Hardwood Silviculture Training Sessions were published. This makes several aspects of the working of the SILVAH system available in published form for the first time. In addition, personnel at Warren developed, tested, and used a software package for assessing several species diversity measures.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4153

Quantitative Methods for Modeling Ecosystem Response
Scott, Charles T., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Integrating models of plant processes with forest and landscape processes	FMR	0	.0			
2. Modeling of oak plant community responses to natural stressors and ecosystem management	FMR	477	3.3	11		5
3. Developing ecosystem management practices for aesthetics, biodiversity, habitat and timber	FMR	454	1.6	3		
4. Monitoring subtle responses of forest ecosystems to global climate change and other stressors.	FMR	76	.6	2		2

Problem 1 **Integrating models of plant processes with forest and landscape processes**
FY 95 Research Attainments

Publications

none

Attainment

No progress to report this period. Work on this Problem is largely complete. As progress continues in Problem Area 2, the conceptual model will be revised and refined as necessary. For example, Barrett's work on mammal distributions will be added to the model.

Problem 2 **Modeling of oak plant community responses to natural stressors and ecosystem management**
FY 95 Research Attainments

Publications

Research Unit

Barrett, Hope R. 1995. Catalog of long-term research conducted within the USDA Forest Service, Northeastern Forest Experiment Station. In: Meeting of the Northern Global Change Program: abstracts; 1995 March 14-16; Pittsburgh, PA. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 34. Abstract.

Barrett, Hope R.; Iverson, Louis R.; Prasad, Anantha. 1995. Mammal habitat characterization for county-level global change modeling. In: Excellence in wildlife stewardship through science and education: the Wildlife Society 2nd annual conference; 1995 September 12-17; Portland, OR. Bethesda, MD: Wildlife Society: 8. Abstract.

Barrett, Hope R. 1995. Catalog of long-term research conducted within the USDA Forest Service, Northeastern Forest Experiment Station. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 14. Abstract.

Hale, Betsy J.; Sutherland, Elaine Kennedy; Hix, David M. 1995. Grouping of central United States tree species as a function of regeneration attributes. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 107. Abstract.

Iverson, Louis R.; Brown, Sandra; Prasad, A. 1994. Estimating potential tropical forest biomass of south-southeast Asia. In: Remote sensing for tropical forest assessment. Gen. Tech. Rep. SO-113. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 24.

Iverson, Louis R.; Cook, Elizabeth A.; Graham, Robin L. 1994. Regional forest cover estimation via remote sensing: the calibration center concept. Landscape Ecology. 9 (3): 159-174.

Iverson, Louis R.; Hutchinson, Todd F.; Sutherland, Steve; Windus, Jennifer. 1995. Integrated moisture index as a predictor of vascular plant species composition and richness in southeast Ohio oak forests. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 129. Abstract.

Sutherland, E.K.; Grissimo-Mayer, H.; Woodhouse, C.A.; Covington, W.W.; Horn, S.; Huckaby, L. 1995. Two centuries of fire in a southwestern Virginia Pinus pungens community. In: Inventory and management techniques in the context of catastrophic events: altered states of the forest; 1993 June 21-24; University Park, PA. University Park, PA: Pennsylvania State University, Center for Statistical Ecology and Environmental Statistics:

(Distributed electronically on one 3-1/2 inch computer disk.)

Sutherland, Elaine Kennedy; Grissino-Mayer, Henri; Woodhouse, Connie. 1995. The role of fire in community structure and development of a southwestern Virginia, USA Pinus pungens stand. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 259. Abstract.

Sutherland, Elaine Kennedy; Yaussy, Daniel A.; Boerner, Ralph E.J. 1995. Mortality patterns in oak forests along a climatic and acid deposition gradient. In: Meeting of the Northern Global Change Program: abstracts; 1995 March 14-16; Pittsburgh, PA. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 64. Abstract.

Yaussy, D.A.; Sutherland, E.K. 1995. Relationships of the southern oscillation of the Pacific Ocean and droughts and wildfires in the Ohio River Valley. In: Inventory and management techniques in the context of catastrophic events: altered states of the forest; 1993 June 21-24; University Park, PA. University Park, PA: Pennsylvania State University, Center for Statistical Ecology and Environmental Statistics:

(Distributed electronically on one 3-1/2 inch computer disk.)

Cooperative

Boerner, Ralph E.J.; Sutherland, Elaine Kennedy. 1995. Relative nitrogen mineralization and nitrification potentials in relations to soil chemistry in oak forest soils along a historical deposition gradient. In: Meetings of the Northern Global Change Program: abstracts; 1995 March 14-16; Pittsburgh, PA. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 35. Abstract.

Boerner, Ralph E.J.; Sutherland, Elaine Kennedy. 1995. Nitrogen dynamics in oak forest soils along a historical deposition gradient. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 523-533.

Morris, Sherri J.; Decker, Kelly L.M.; Boerner, R.E.J.; Sutherland, Elaine K. 1995. Interactions between site management and long-term acidification on soil nitrogen dynamics and microbial abundance in oak forests. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to the Bulletin of the Ecological Society of America. 76(2): 190. Abstract.

Roberts, Bruce R.; Kohorst, Sanford D.; Decker, Henry F.; Yaussy, Daniel. 1995. Short biomass of turfgrass cultivars grown on composted waste. Environmental Management. 19 (5): 735-739.

Schwartz, Mark W.; Iverson, Louis R. 1995. Modeling the role of habitat fragmentation on the ability of trees to respond to climatic warming. In: Meeting of the Northern Global Change Program: abstracts; 1995 March 14-16; Pittsburgh, PA. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 26. Abstract.

Attainment

A study across the Ohio Valley revealed that some soil characteristics are related to the atmospheric deposition gradient. Soil pH, NO3-, and Ca2+ decreased and soil organic C and extractable Al3+ increased from west to east. Important site factors related to mortality on these sites were drought within last 5 years, soil nitrogen, tree species, and the tree's relative size. Area burned in the Midwest was found to be related to Palmer's drought index and to El Nino, thus predicting severe fire seasons more than 5 months ahead. Table Mountain pine establishment was found to follow fires, which occurred in a Virginia site every 10 years or so until 1940 when fires were excluded. Thus the communities are declining.

The Integrated Moisture Index (IMI) was found to predict both herbaceous and woody plant distributions. IMI combines solar radiation, water flow, curvature, and soil depth into a single variable.

A catalog of long-term data sets was assembled for the Northeastern and North Central Forest Experiment Stations. Users can search for attributes they are interested in, and then are given the data source.

A simulation study of the effect of forest fragmentation on tree species migration revealed that forests are not likely to migrate faster than 50 km per century, or about 10 times slower than may be necessary under global change. Rates drop to 1-10 km/century if areas are less than 30% forested.

Problem 3 **Developing ecosystem management practices for aesthetics, biodiversity, habitat and timber**
FY 95 Research Attainments

Publications

Research Unit

Dale, Martin E.; Smith, H. Clay; Pearcy, Jeffrey N. 1995. Size of clearcut opening affects species composition, growth rate, and stand characteristics. Res. Pap. NE-698. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 21.

Sutherland, Elaine Kennedy; Hale, Betsy J.; Hix, David M. 1995. Regeneration attributes of tree species in the central hardwoods type. In: Meeting of the Northern Global Change Program: abstracts; 1995 March 14-16; Pittsburgh, PA. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 63. Abstract.

Yaussy, Daniel A. 1994. Quality improvements to OAKSIM and NE-TWIGS. Compiler. 12 (4): 18-22.

Attainment

Using plots installed 30 years earlier, the role of the size of forest opening on species composition and growth was studied. Openings from 0.04 to 1.6 acres were cut in oak-hickory forests. Oak and hickory dominated the regeneration on poor sites, while yellow poplar dominated on good sites. Number of stems, basal area, and volume all increased with size of opening, due to the edge effect from the residual stand. The ratio of intolerant to tolerant species also increased with size of opening, thus shifting from clearcutting to small group selection of unevenaged management will greatly alter the species composition in oak-hickory forests.

The use of growth and yield plots versus permanent sample plots were evaluated based on two criteria. Growth and yield plots were found to not be representative of the forest population, because they favored a few commercial species. Permanent sample plots were found to be too small to adequately represent stand characteristics and had little stand history information available. The plot types can be linked, improving both growth and yield models and regional forest survey results and projections.

Methods to estimate present and future tree quality have been added to the OAKSIM and NE-TWIGS growth and yield computer simulators. These additions allow better estimates of stand value and thinning options which should result in better management decisions.

Problem 4 **Monitoring subtle responses of forest ecosystems to global climate change and other stressors.**
FY 95 Research Attainments

Publications

Research Unit

Iverson, Louis R.; Graham, Robin L.; Cook, Elizabeth A. 1994. Methodological aspects of using AVHRR data: calibrating AVHRR data with Landsat. In: Remote sensing for tropical forest assessment. Gen. Tech. Rep. SO-113. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 20-21.

Scott, Charles T.; Bechtold, William A. 1995. Techniques and computations for mapping plot clusters that straddle stand boundaries. In: Techniques for forest surveys when cluster plots straddle two or more conditions. Forest Science Monograph. 31: 46-61.

Cooperative

Kohl, Michael; Scott, Charles T.; Zingg, Andreas. 1994. Permanent monitoring plots: potential and limitations. In: Innes, John L., ed. Assessment of increment in permanent monitoring plots established to determine the effects of air pollution on forests: proceedings of the Sopron workshop; 1993 August 28-September 1; Sopron, Hungary. Birmensdorf, Switzerland: Swiss Federal Institute for Forest, Snow and Landscape Research: 17-24.

Kohl, Michael; Scott, Charles T.; Zingg, Andreas. 1995. Evaluation of permanent sample surveys for growth and yield studies: a Swiss example. Forest Ecology and Management. 71: 187-194.

Attainment

A method for combining Landsat Thematic Mapper (TM), Advanced Very High Resolution Radiometer (AVHRR), and biogeographic data to estimate forest cover over large regions was developed and tested. TM data were used to classify a small area into forest/nonforest. AVHRR data for the same area were then related to the TM data. The relationships were than applied for the entire area using the less expensive AVHRR data to provide accurate estimates of forest cover for large regions.

The common problem of sample plots falling across cover type and forest boundaries was addressed by a boundary mapping technique. Boundaries which cross the plot are mapped using a few simple measurements. Each plot segment is classified by cover type. Trees and other plot features are assigned to each segment. Equations were derived to compute the segment areas and the unbiased estimates of forest cover and of tree and plot characteristics.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4154

Ecology and Management of Northern Hardwoods and Associated Ecosystems

Garrett, Peter W., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Understand and document the structure and dynamics of northern hardwood ecosystems	FMR	314	3.0	9	2	
2. Better understand the ecological relationships between wildlife habitat and forest management	FMR	314	1.0	2	4	
3. Need to preserve undisturbed areas to study natural succession and impacts of global change	FMR	118	.5	2	2	1
4. Need to preserve integrity of older plantations to document responses to environmental change	FMR	39	.5			

Problem 1 **Understand and document the structure and dynamics of northern hardwood ecosystems**
FY 95 Research Attainments

Publications

Research Unit

Bergdahl, D.R.; Bove, J.R.; Sendak, P.E.; Tobi, D.R. 1994. Using a geographic information system to quantify volumes of defect, decay and merchantable wood in diseased sugar maples. Phytopathology. 84 (10): 1144.

Carpenter, Constance; Smith, Marie-Louise. 1994. Ecological classification and mapping (ECOMAP) in the Northeast: a tool for ecosystem management. In: McEvoy, Thom J., ed. Ecosystem management: proceedings of a symposium; 1994 July 18-19; Burlington, VT. Burlington, VT: University of Vermont: 46-52.

Dennis, Donald E.; Sendak, Paul E. 1995. Trends in stumpage prices. In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 10. Abstract.

Garrett, Peter W.; Graber, Raymond E. 1995. Sugar maple seed production in northern New Hampshire. Res. Pap. NE-697. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 6.

Leak, William B.; Cullen, J.B.; Frieswyk, Thomas S. 1995. Dynamics of white pine in New England. Res. Pap. NE-699. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 8.

Sendak, Paul E.; Huyler, Neil K. 1994. Timber management and use-value assessment. Res. Pap. NE-691. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 8.

Smith, Marie-Louise. 1995. Community and edaphic analysis of upland northern hardwood communities, central Vermont, USA. Forest Ecology and Management. 72: 235-249.

Smith, Marie-Louise. 1995. Landscape level. In: Biodiversity principles and applications: conference for natural resource professionals in New Hampshire: summary; 1995 January 17; Durham, NH. Durham, NH: University of New Hampshire Cooperative Extension: 18.

Solomon, Dale S.; Herman, David A.; Leak, William B. 1995. FIBER 3.0: Ecological growth model for northeastern forest types. Gen. Tech. Rep. NE-204. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 24.

Extramural

Byron, Tom M. 1995. Natural white pine regeneration in New Hampshire. Durham, NH: University of New Hampshire. 71. M.S. thesis.

(Funded by NE-4154 (Cooperative Agreement 23-724). Project scientist was member of graduate committee and student advisor.)

Gregoire, Timothy G.; Schabenberger, Oliver; Barrett, James P. 1995. Linear modelling of irregularly spaced, unbalanced, longitudinal data from permanent-plot measurements. Canadian Journal of Forest Research. 25: 137-156.

(Funded in part by NE-4154, Cooperative Agreement 23-724.)

Attainment

Ecosystem management is based on an understanding of land capability, socio-economic relations, and forest biology. Advances were made in all of these areas during the past year. An ecological multifactor approach was used to identify upland northern hardwood ecologic types and natural species groupings in Vermont. Each type was characterized by landscape position, late-successional vegetation, and soils, providing a basis for evaluating land potential and management direction. The application of ecological classification (ECOMAP) to ecosystem management and biological diversity in the Northeast was described. Longterm investment in forest management has advantages over some other types of investment: hardwood sawtimber stumpage prices in the NE over the past 31 years were shown to have exceeded inflation rates, while softwood sawtimber and pulpwood prices kept pace. An examination of timber management under the Vermont Use Value Appraisal Program showed that participating ownerships contributed substantially to the economy: 31% of properties were harvested in 1989 accounting for 18-24% of the State's sawlog and pulpwood/fuelwood harvest and the enrolled land represented about 16% of the timberland. Based on a reanalysis of FIA plots, growth of white pine in comparison with red maple was found to be adequate in all New England states except Rhode Island. Lack of seedling/sapling stands and deficiencies in diameter distribution indicates a need for more work on regeneration and release of white pine.

Problem 2 **Better understand the ecological relationships between wildlife habitat and forest management**
FY 95 Research Attainments

Publications

Research Unit

Costello, Christine; Yamasaki, Mariko; Pekins, Peter J. 1995. Songbird response to group selection harvests and clearcuts on the White Mountain National Forest. In: Abstracts from 51st annual northeast fish and wildlife conference; 1995 April 9-12; Ocean City, MD. Annapolis, MD: Maryland Department of Natural Resources: 16. Abstract.

Costello, Christine A. 1995. Songbird response to group selection harvests and clearcuts on the White Mountain National Forest. Durham, NH: University of New Hampshire. 94. M.S. thesis.

Extramural

Campbell, Bob. 1995. Investigation of stream gradient relationship to abundance of stream-dwelling salamander populations in the US Forest Service Experimental Forest in Bartlett New Hampshire. Keene, NH: Antioch New England Graduate School. 26. M.S. thesis.

(Project financed this research on the Bartlett Experimental Forest and our Wildlife Biologist helped organize and direct the field work and was a member of the graduate committee, Cooperative Agreement 23-008.)

Krusic, Rachel. 1995. Habitat use and identification of bats in the White Mountain National Forest. Durham, NH: University of New Hampshire. 86. M.S. thesis.

(NE-4154 funded this research, provided research facilities and technical support, and one of our scientists served on the graduate committee, Cooperative Agreement 23-636.)

Sasse, D. Blake; Pekins, Peter J. 1994. The summer roosting behavior of bats on the White Mountain National Forest. Bat Research News. 34 (4): 113-114.

(Project financed work on Experimental Forest and scientist served as research advisor and member of graduate committee, Cooperative Agreement 23-636.)

Sasse, David Blake. 1995. Summer roosting ecology of bats in the White Mountain National Forest. Durham, NH: University of New Hampshire. 54. M.S. thesis.

(NE-4154 funded this research and one of our scientists served on the graduate committee, Cooperative Agreement 23-636.)

Attainment

A better understanding of the ecological relationships between wildlife habitat and forest management at the stand, landscape, and regional levels is needed to integrate wildlife habitat maintenance and improvement with other forest management goals including timber production and aesthetic qualities. Progress on this problem included completion of four MS theses on neotropical migratory birds (1), bats (2), and stream-dwelling salamanders (1). Bird work involved songbird response to group selection and small clearcuts in northern hardwoods. Bat studies looked at present and summer habitat usage. A second study used radio-telemetry to investigate summer roosting ecology of bats. The salamander study assessed the relationship of abundance of stream-dwelling species to stream gradient. These graduate level studies reflect the high degree of management interest in wildlife habitats, especially for non-game species, and lack of practical information on managing these resources that land managers require in the application of ecosystem management on public and private lands. The Project also provides technical assistance on monitoring small mammal communities on the National Forests in accordance with the requirements in Forest Plans.

Problem 3 **Need to preserve undisturbed areas to study natural succession and impacts of global change**
FY 95 Research Attainments

Publications

Research Unit

Leak, William B.; Yamasaki, Mariko; Smith, Marie-Louise; Funk, David T. 1994. Selection criteria for forested natural areas in New England, USA. Natural Areas Journal. 14 (4): 300-305.

Scott, Charles T.; Tyrrell, Lucy E.; Smith, Marie-Louise; Parker, Linda R.; DeMeo, Thomas E. 1995. A proposed monitoring system for research natural areas in the Northeast and Midwest. In: Ecosystem management & restoration for the 21st century: paper and program abstracts: 21st annual natural areas conference; 1994 October 19-22; Palm Beach Gardens, FL. [Place of publication unknown]: Publisher name unknown]. Abstract.

Cooperative

Schlessinger, Richard C.; Funk, David T.; Roth, Paul L.; Myers, Charles C. 1994. Assessing changes in biological diversity over time. Natural Areas Journal. 14 (4): 235-240.

Extramural

Carbonneai, Lee E.; Allen, Sarah D. 1995. Botannical reconnaissance of the Bowl Research Natural Area. Gen. Tech. Rep. NE-189. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 26.

Selva, Steven B. 1993. Lichen diversity and stand continuity in the ancient forests of New Hampshire and Vermont. American Journal of Botany (Suppl.). 80 (6): 11.

(Research partially funded by Project NE-4154, Cooperative Agreement 23-669.)

Attainment

Goals of this Problem are the establishment of Research Natural Areas (RNAs), to collect baseline data, and conduct other non-destructive research in these areas. Initiatives directed at this problem in the past year have focused on three areas: (1) Support of baseline data collection - six important studies were completed on broad botanical surveys and specific studies of lichen associated with old-growth forests. (2) Development of a baseline monitoring protocol for a variety of ecosystems, but targeted for use with reference to RNAs. This is a cooperative effort with Region 9, NCFES, and several projects in NEFES. Will result in a joint Station publication of three volumes. (3) Development of the theoretical and practical considerations relative to establishment of a representative RNA network. Several publications completed on selection criteria for RNAs and assessing changes in biological diversity over time.

Problem 4 **Need to preserve integrity of older plantations to document responses to environmental change**
FY 95 Research Attainments

Publications

none

Attainment

Records were examined and lists of potentially valuable plantings established by the Durham genetics project starting in the late 1920's. The Burlington sugar maple project starting in the 1960's, and the New Lisbon hybrid pine project starting in 1971 were assembled. The next step will be to visit plantings and decide which ones should be retained, remeasured, and entered in a data bank.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4251

Wildlife Communities and Habitat Relationships in New England Forests

DeGraaf, Richard M., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Wildlife community responses to alternative silvicultural systems in northern hardwoods	FER	485	1.0			
2. Relationship between stand structure and abundance of mammals in New England oak forests	FER	208	2.0			2
3. Effects of forest management on amphibians and amphibian habitats in a changing global environ.	FER	53	1.0	1		

Problem 1 **Wildlife community responses to alternative silvicultural systems in northern hardwoods**
FY 95 Research Attainments

Publications

none

Attainment

Predation on bird nests is generally considered to be a major cause of mortality for many species. Nest predation has been implicated in the decline of some species, and elevated nest predation rates have been described as edge effects, i.e., evidence of habitat fragmentation. Does even-aged management with clearcut harvesting in extensive forest produce elevated nest predation rates? Comparison of predation rates in large block of reserved and managed areas in extensive forest showed no difference in nest predation rates, suggesting that extensive hardwood-dominated forests in northern New England are not fragmented by even-aged forest management. Furthermore, no avian nest predators were detected in extensive forest – all predators were mammals.

Problem 2 **Relationship between stand structure and abundance of mammals in New England oak forests**
FY 95 Research Attainments

Publications

Cooperative

Cooper, Robert J.; Dodge, Kevin M.; Thurber, Dale K.; Whitmore, Robert C.; Smith, Harvey R. 1994. Response of ground-level wildlife food plants to canopy defoliation by the gypsy moth. Proceedings of the annual conference southeastern association of fish and wildlife agencies. 47: 268-275.

Cooper, Robert J.; Smith, Harvey R. 1995. Predation on gypsy moth (Lepidoptera: Lymantriidae) egg masses by birds. Environmental Entomology. 24 (3): 571-575.

Attainment

From 1989 through 1993, the mean annual production of sound acorns in oak forests in Massachusetts ranged from 7 to 680 Kg/ha, oven-dry weight. Densities of white-footed mice, a key predator of gypsy moth and vector of Lyme disease, ranged from less than 10 to about 100/ha. Much of the annual variation in white-footed mouse abundance was explained by the size of the acorn crop. Mouse densities declined or remained at low levels when acorn production was low the previous autumn and increased or remained at high levels following large acorn crops. Despite abundant acorn crops in mature oak stands, browsing by white-tailed deer can prevent the establishment of oak seedlings. Deer populations of 10-17/Km2 prevented regeneration. At these deer densities, maturing oak stands developed a park-like structure, with poorly developed understory and midstory layers. Future stands will be dominated by fewer species and oaks and other species that are common now will be less abundant. If these oak forests are to be managed to maintain the current levels of diversity, deer populations will have to be reduced below the recent densities of 10-17/Km2. Where deer numbers have been limited to 3-6/KM2, understory vegetation is abundant. At these lower deer densities, stands mature naturally into old growth and regenerate when disturbed. Thus, deer densities of 3-6/KM2 have been compatible with maintaining these oak forests and deer densities above 10/Km2 have not.

Problem 3 **Effects of forest management on amphibians and amphibian habitats in a changing global environ.**
FY 95 Research Attainments

Publications

Research Unit

Brooks, Robert T.; Doyle, Katherine L. 1994. White-belted coloration in a masked shrew, Sorex cinereus, from Massachusetts. Canadian Field-Naturalist. 108 (4): 491-492.

Attainment

Amphibian immigration and emigration to each of four temporary ponds was enumerated by species and date during the spring breeding migration. Macroinvertebrates were sampled once monthly for three months (April-June) at five locations in each pond. Pond water levels and simple water chemistry were measured weekly during the period when each pond held water. Precipitation and deposition inputs were measured weekly at an NADP site. Amphibian use of 16 forested stands were sampled monthly using 60 systematically located cover boards in each stand. All temporary ponds within the watershed of the Quabbin reservoir were identified on aerial photographs, mapped, and digitized as a GIS data layer. Land use and land cover within the watershed for the year 1939 are being digitized. Other data layers for the study area are being identified and acquired.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4252

Atlantic Salmon Habitat Restoration Ecology and Management
DeGraaf, Richard (Acting), Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Optimum habitat conditions for juvenile salmon, biological factors that influence fry and parr	FER	262	.0			
2. Determine interspecies interactions from stocking salmon fry in streams with resident fish	FER	35	.0			

Problem 1 **Optimum habitat conditions for juvenile salmon, biological factors that influence fry and parr**
FY 95 Research Attainments

Publications

none

Attainment

This research unit is not staffed; research is being conducted cooperatively and administered by an acting unit leader. Cooperators include professors at Dartmouth College and University of Vermont and the state cooperative fish and wildlife research units at the Universities of Massachusetts and Vermont. FY 1995 activities included collecting data during the second year of planned five-year studies and preparing preliminary data summaries from the first field season. Initial surveys of streams in Maine and Canada were completed. Analysis of data is underway. Study establishment reports have been developed for studies initiated in FY 1994. These office reports are used to track accountability and document the first phase of studies, but no published research reports are available yet.

Problem 2 **Determine interspecies interactions from stocking salmon fry in streams with resident fish**
FY 95 Research Attainments

Publications

none

Attainment

This research unit is not staffed; research is being conducted cooperatively and administered by an acting unit leader. Cooperators include professors at Dartmouth College and the University of Vermont and state cooperative fish and wildlife research units at the Universities of Massachusetts and Vermont. FY 1995 activities included collecting data during the second field season of planned five-year studies and preparing preliminary data summaries from the first field season in 1994. A number of age class 0 (hatched in 1995) and age class 1 (hatched in 1994) parr were captured, tagged, and released and the feeding preferences analyzed. Tags will also enable researchers to follow and recapture during and after winter, to estimate over-winter survival and associate locations of recaptured fish with habitat features enhancing overwinter survivability. Because research began in 1994, no published research reports are available yet, although study establishment and progress reports necessary for tracing and accountability purposes have been completed for the files.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4351

Enhancement of the Human Habitat Through Management of Natural Environments

Corbett, Edward S., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
2. Quantifying cumulative effects of atmospheric deposition, biotic factors and multiple use mgt.	FER	234	1.3	1		3
M1. Long-term watershed studies	FER	26	.2			1

Problem 2 **Quantifying cumulative effects of atmospheric deposition, biotic factors and multiple use mgt.**
FY 95 Research Attainments

Publications

Research Unit

Davidson, Walter H. 1995. Evaluation of the effect of excelsior pads on the survival of oak and ash seedlings. Green Lands. 25 (3): 44-45.

Cooperative

Lynch, James A.; Corbett, Edward S. 1995. Nitrate export from managed and unmanaged forested watersheds in the Chesapeake Bay watershed. In: Hill, Paula; Nelson, Steve, eds. Toward a sustainable coastal watershed: the Chesapeake experiment: proceedings of the 1994 Chesapeake research conference; 1994 June 1-3; Norfolk, VA. CRC Publ. 149. Edgewater, MD: Chesapeake Research Consortium: 656-664.

Lynch, James A.; Horner, Kevin S.; Grimm, Jeffrey W.; Corbett, Edward S. 1995. Atmospheric deposition: spatial and temporal variations in Pennsylvania–1994. University Park, PA: Pennsylvania State University, Environmental Resources Research Institute; ER9504. 94 p.

(An analysis of state-wide atmospheric deposition data; includes 13-year trends.)

Lynch, James A.; Horner, Kevin S.; Grimm, Jeffrey W.; Corbett, Edward S. 1995. Atmospheric deposition: spatial and temporal variations in Pennsylvania–1994. University Park, PA: Pennsylvania State University, Environmental Resources Research Institute; ER9504A. 337 p.

(Includes specific chemical analyses, statistics, trends, and maps of ionic concentrations and depositions.)

Attainment

The following reflects major accomplishments for the life of this problem. We quantified how various portions of a forested watershed contribute to streamflow during storm events. Under dry antecedent soil moisture conditions the initial flow rates and hydrograph peak are produced by stormflow contributions from the channel and base slope zones, primarily in the front 30% of the watershed. Under wet antecedent conditions the front half of the watershed produces the initial flow increases, while the back half was the major contributor to recession stormflow. Subsurface flow through macrospores comprise 75% to 93% of stormflow volume. Work has shown that rapid depressions in streamflow pH and alkalinity can occur over short periods of time in response to storm inputs during seasons other than the spring snowmelt period. Streamflow alkalinity can remain depressed for a substantial period after a major storm on some watersheds placing aquatic organisms at risk. Models were developed to predict fluctuations in stormflow pH, alkalinity, and total acidity. Fecal streptococci densities as high as 25,000/100 ml were observed in stream samples during periods of heavy gypsy moth defoliation. Fecal coliform and total coliform densities exceeded 90/100 ml and 400/100 ml. These data indicate that defoliation residues can be a potential contamination source for municipal water supplies. Heavy defoliation can increase water yields up to 5.4 inches or 146,000 gal./acre/year. A model was developed to improve spatially reliable estimates of atmospheric deposition. We found there has been a reduction in calcium and magnesium concentrations in precipitation over the past several years. This loss of acid neutralizing capacity has offset some of the beneficial reductions in atmospheric sulfate and nitrate.

Problem M1 **Long-term watershed studies**
FY 95 Research Attainments

Publications

Cooperative

Hornbeck, J.W.; Adams, M.B.; Corbett, E.S.; Verry, E.S.; Lynch, J.A. 1995. A summary of water yield experiments on hardwood forested watersheds in northeastern United States. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 282-295.

Attainment

The following reflects major accomplishments for the life of this problem. A survey showed that over 2 million acres of land are under control of over 750 municipalities, private water companies, and State and Federal agencies for management as either water-source areas or protection lands for municipal water supplies. Converting an open-land municipal watershed to a young pine forest caused a decline in water yield of 238,000 gallons of water per year per acre reforested. This is equivalent to a layer of water almost 9 inches deep over the entire watershed. Conversion of riparian-zone vegetation from hardwoods to grass increased watershed streamflow about 2 inches but was accompanied by serious erosion problems due to the mechanical methods used. Thinning the pine stand by removing every other row of trees had little effect on water yield. Long-term impacts of a commercial forest harvest on stream water chemistry and nutrient loss were determined. Clearcutting 44.5 ha of a 104 ha watershed resulted in periodic increases of nitrate, potassium, and some macronutrients for up to nine years following harvesting. However, the losses were very small and considered insufficient to affect site fertility and productivity. Implementation of periodic post-harvest inspections and leaving adequate buffer zone widths along all perennial and intermittent stream channels, in addition to other Best Management Practices, can hold the impacts of silvicultural activities within acceptable water quality limits. As a result of this research, adjusted Best Management Practices are now being applied to harvesting operations on State and private lands in Pennsylvania and New York.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4352

Dynamics of Atmosphere, Vegetation, Soil & Water in Mature & Harvested Forests in New England

Eagar, Christopher, Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. To what degree do harvesting and/or acid precip. deplete nutrient capitals of New England	FER	412	2.0	4		
2. What is the sequence of regeneration following conventional and intensive harvesting in forests	FER	59	.3	1		
4. What are the implications of highly acidic Cone Pond for understanding acidification of ecosystems	FER	236	1.3	3	1	
5. Pathways of water and nutrient movement through forest soils. Can a useful model be developed?	FER	118	.5	2		2
M1. The HBEF will be maintained for ecosystem research biosphere reserve and for LTER	FER	294	1.2		2	2

Problem 1 **To what degree do harvesting and/or acid precip. deplete nutrient capitals of New England**
FY 95 Research Attainments

Publications

Research Unit

Hislop, J.E.; Hallett, R.A.; Hornbeck, J.W. 1995. Microwave digestion of forest soil and plant tissue samples. In: 1995 international symposium on soil and plant analysis; 1995 August 5-10; Wageninen, the Netherlands. [Place of publication unknown]: [Publisher name unknown]: 43. Abstract.

(Poster.)

Hornbeck, J.W.; Adams, M.B.; Corbett, E.S.; Verry, E.S.; Lynch, J.A. 1995. A summary of water yield experiments on hardwood forested watersheds in northeastern United States. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 282-295.

Hornbeck, J.W.; Verry, E.S.; Dolloff, C.A. 1995. Managing riparian areas in northeastern forests: a quest for desired future conditions. In: Managing forests to meet peoples' needs: proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 September 18-22; Anchorage, AK. SAF Publ. 95-02. Bethesda, MD: Society of American Foresters: 299-304.

Pardo, L.H.; Driscoll, C.T.; Likens, G.E. 1995. Acidification and nitrogen deposition effects on an experimentally generated chronosequence. In: Acid "Rain" 95? Proceedings, 5th international meeting on acidic deposition; 1995 June 25-30; Gothenburg, Sweden. [Place of publication unknown]: [Publisher name unknown]: 246. Abstract.

Attainment

Research is being conducted to assess N15 in soil as a regional indicator of nitrate loss in streams at HBEF, Cone Pond, and the Bowl RNA in the WMNF. Field and laboratory work has been completed on a study of cation depletion in low elevation forest soils of northern New England. Samples of soils, wood, and foliage from a gradient that stretches from New York to Maine show forests occurring on outwash sands that were previously harvested and farmed have dangerously low levels of nutrient cations, especially calcium. Such forests will require special management prescriptions, including carefully designed selection cuttings and low rotations, to protect nutrient capitals and forest health and productivity.

Methods were tested and developed for using microwave digestion to obtain nutrient contents of soil, foliage, and wood samples. The tests were conducted on international standard reference samples and recommendations were developed for cooking times, and types of strengths of digest acids. The study showed that microwave digestion is a safe and efficient method for obtaining total nutrient contents, but further work is needed to develop methods for digesting soils with high organic matter contents.

The impacts of precommercial thinning and fertilization on water quality were determined for a spruce-fir forest in central Maine. Thinning of a 10-year old stand and addition of 200 kg/ha of nitrogen fertilizer had no measurable impact on chemical content of streamflow or groundwater. These findings have important implications for central Maine where thousands of hectares of forest are annually subjected to precommercial thinning and fertilization.

Problem 2 **What is the sequence of regeneration following conventional and intensive harvesting in forests**
FY 95 Research Attainments

Publications

Research Unit

Martin, C. Wayne. 1995. Development of a central hardwood stand following whole-tree clearcutting in Connecticut. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 37-46.

Attainment

Little information is available concerning the initial stages of forest regeneration following intensive harvesting of central hardwood stands in the northeastern part of the range. Establishment of commercial species, density and rate of biomass accumulation of the regeneration are of major concern to both foresters and landowners contemplating a harvest. To help provide this information, a 6-ha forest stand dominated by the central hardwood forest type of Connecticut was mechanically whole-tree clearcut in 1981. Intensive sampling of the regeneration including herbs, shrubs, tree seedlings, and stump sprouts was conducted the first, third, fifth, and tenth years after cutting. Prior to harvesting, the stand contained 1,163 stems per ha, greater than 2.0 m d.b.h.; at year 10 there were 9,500. At year 10 the trees and shrubs greater than 2.0 cm d.b.h. had accumulated 20% of the preharvest levels of biomass, 52% of nitrogen, and 21% of calcium. Based on data from the first 10 years after clearcutting, the future forest should be similar to the preharvest forest with red maples, oaks, and birches being the most numerous trees.

Problem 4 **What are the implications of highly acidic Cone Pond for understanding acidification of ecosystems**
FY 95 Research Attainments

Publications

Research Unit

Bailey, S.W. 1994. Differentiating between weathering and cation loss in a base-poor watershed. In: Proceedings, 1994 fall meeting of the American Geophysical Union; 1994 December 5-9; San Francisco, CA. Washington, DC: American Geophysical Union: 75(44): 279. Abstract.

Bailey, Scott W.; Driscoll, Charles T.; Hornbeck, James W. 1995. Acid-base chemistry and aluminum transport in an acidic watershed and pond in New Hampshire. Biogeochemistry. 28: 69-94.

Bailey, Scott Waverly. 1994. Biogeochemistry of aluminum and calcium in a linked forest-aquatic ecosystem. Syracuse, NY: Syracuse University. 86 p. Ph.D. dissertation.

Extramural

Fox, Jennifer Anne. 1995. An examination of NO3–N movement in the Cone Pond watershed in central New Hampshire. Durham, NH: University of New Hampshire. 52 p. M.S. thesis.

Attainment

Comparative analysis of Cone Pond, Hubbard Brook and Sleepers River is yielding insight into the effects of geologic substrate and disturbance history on acidification of ecosystems and health of forest and aquatic environments. Despite significant declines in atmospheric sulfate deposition, high sulfate loss from the Cone Pond watershed continues, as does the high export of aluminum from forest soils. Retention of aluminum in the pond is preventing the generation of alkalinity. Aluminum concentrations in the pond and stream are well above the level considered toxic to trout. The reason for this watershed's apparent inability to respond to reductions in sulfate deposition appear to be due to a low weathering rate coupled with patterns of sulfur storage and release in forest soils. Mechanisms and rates of these processes are currently under investigation. Study of nitrogen in soil water and carbon to nitrogen ratio of soil suggests that the Cone Pond watershed has still not recovered from the effects of a forest fire c.1820. Although the forest has fully regrown, the soil quality may still be impacted, 175 years after the fire, resulting in immobilization of nitrogen in the soil, and alteration of the chemistry of stream water. Results from this study have direct application for managing forest and aquatic ecosystems in central New England that are acidified or have had significant past disturbances.

Problem 5 **Pathways of water and nutrient movement through forest soils. Can a useful model be developed?**
FY 95 Research Attainments

Publications

Research Unit

Hornbeck, James W.; Smith, Robert B. 1995. A water resources decision model for forest managers. In: Proceedings, caring for the forest: research in a changing world; 1995 August 6-12; Tampere, Finland. 32. Abstract.

Pardo, L.H.; Hornbeck, J.W. 1995. Natural abundance of 15N as a tool for assessing nitrogen patterns from forest soils. Bulletin of the Ecological Society of America. 76(2): 205. Abstract.

Cooperative

Ollinger, Scott V.; Aber, John D.; Federer, C. Anthony; Lovett, Gary M.; Ellis, Jennifer M. 1995. Modeling physical and chemical climate of the northeastern United States for a geographic information system. Gen. Tech. Rep. NE-191. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 30 p.

Rauscher, H.M.; Twery, M.; Palmer, J.; Hoffman, R.; Stout, S.; Steinman, J. 1995. Northeast Decision Model design document. AI Applications. 9 (3): 85-86.

(Includes electronic insert of 2 disks.)

Attainment

Four decades of forest hydrology research in northeastern United States has provided broad knowledge on relationships betweeen forests and streamwater quantity and quality. We have incorporated this knowledge into a decision model to help forest managers protect and enhance water resources. The model is in a user-friendly format for personal computers, and allows the user to choose combinations from 5 management objectives or goals related to water quality and 5 related to water quantity. All users are first provided with information about Best Management Practices required to control nonpoint source pollution of aquatic ecosystems. Based upon the options selected, and taking into account forest stand and precipitation data provided by the user, one of 6 possible silvicultural systems is recommended to meet management objectives. Impacts of the recommended silvicultural system on water quality and quantity are provided in text and tables.

Problem M1 **The HBEF will be maintained for ecosystem research biosphere reserve and for LTER**
FY 95 Research Attainments

Publications

Cooperative

Jagels, Richard; Hornbeck, James; Marden, Susan. 1994. Drought and cold stress-induced morphometric changes in tree rings of red spruce. Tech. Bull. 159. Orono, ME: University of Maine, Maine Agricultural and Forest Experiment Station.

Zak, Donald R.; Tilman, David; Parmenter, Robert R.; Rice, Charles W.; Fisher, Frederick M.; Martin, C. Wayne. 1994. Plant production and soil microorganisms in late-successional ecosystems: a continental-scale study. Ecology. 75 (8): 2333-2347.

Extramural

Christ, Martin; Zhang, Yimin; Likens, Gene E.; Driscoll, Charles T. 1995. Nitrogen retention capacity of a northern hardwood forest soil under ammonium sulfate additions. Ecological Applications. 5 (3): 802-812.

Johnson, Chris E.; Siccama, Thomas G.; Driscoll, Charles T.; Likens, Gene E.; Moeller, Robert E. 1995. Changes in lead biogeochemistry in response to decreasing atmospheric inputs. Ecological Applications. 5 (3): 813-822.

Attainment

The Hubbard Brook Experimental Forest has been operating for 40 years as a biosphere reserve dedicated to ecosystem research. About 600 visitors per year receive information on long-term trends in climate, acidic deposition, and timber harvesting. The forest hosted 4 Russian scientists in 1995; one for 3 months.

Fieldwork for a detailed bedrock map of HBEF was completed in August. The map, authored by USFS and USGS geologists, is now in press. A major finding of this study is that although the general rock type is fairly consistent across the valley, there are significant differences in chemical and mineralogic content. Knowledge of this spatial variability adds power to the watershed experimental design in that the role of soils and geology in the forest's long-term ability to acquire nutrients and resist damage from pollutants can be evaluated.

Increased awareness of values and uses of riparian areas in northeastern forests presents an excellent opportunity to expand management efforts. Operationally defined, standard-width riparian areas should be phased out in favor of shapes and sizes based on ecology of plants and animals, ecosystem processes, and desired uses. A matrix of management options was developed based on successional stages, species composition, and human disturbances. Implementation will require commitments and tradeoffs by owners, users, and managers of riparian areas, but should lead to healthier riparian and aquatic ecosystems, and a minimum of controversy.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4353

Sustainable Forest Ecosystems in the Central Appalachians
Adams, Mary Beth, Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Information needed on historical disturbance patterns and influences on ecosystem processes	FMR	117	1.2			2
2. Quantitative information needed about important ecosystem processes and impacts of disturbances	FER	351	3.0	1	2	10
3. Develop efficient and ecologically sound silvicultural alternatives to complex objectives	FMR	293	1.5	6		1
4. Guidelines for variety of forest management practices and monitoring and mitigation tools	FER	234	1.5	7		1
5. Develop methods to reduce safety risks and costs which characterize wood harvesting industry	FPHR	0	1.0	2		

Problem 1 **Information needed on historical disturbance patterns and influences on ecosystem processes**
FY 95 Research Attainments

Publications

Cooperative

Adams, Harold S.; Stephenson, Steven L.; Lawrence, David M.; Adams, Mary Beth; Eisenback, John D. 1995. Red spruce/hardwood ecotones in the central Appalachians. In: Gottschalk, Kurt W.; Fosbroke, Sandra L., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 522. Abstract.

Gilliam, Frank S.; Adams, Mary Beth. 1995. Plant and soil nutrients in young versus mature central Appalachian hardwood stands. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 109-118.

Attainment

A study was begun to address the historical disturbance pattern, using discs cut from trees harvested on the Fernow Experimental Forest. This study will serve as the basis for a Ph.D. dissertation.

Research on spatial and temporal variability in aquatic invertebrate populations and habitat is continuing.

Problem 2 **Quantitative information needed about important ecosystem processes and impacts of disturbances**
FY 95 Research Attainments

Publications

Research Unit

Adams, M.B.; Kochenderfer, J.N.; Angradi, T.R.; Edwards, P.J. 1995. Nutrient budgets of two watersheds on the Fernow Experimental Forest. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 119-130.

Cooperative

DeWalle, D.R.; Edwards, P.J.; Swistock, B.R.; Drimmie, R.J.; Aravena, R. 1995. Seasonal isotope hydrology of Appalachian forest catchments. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 296. Abstract.

DeWalle, David R.; Tepp, Jeffrey S.; Pickens, Callie J.; Edwards, Pamela J.; Sharpe, William E. 1995. Tree-ring chemistry response in black cherry to ammonium sulfate fertilization. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 179-187.

Dubey, T.; Stephenson, S.L.; Edwards, P.J. 1995. Dimlin effects on leaf-decomposing aquatic fungi on the Fernow Experimental Forest, West Virginia. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 421-429.

Dubey, Tara; Stephenson, Seven L.; Edwards, Pamela J. 1994. Effect of pH on the distribution and occurrence of aquatic fungi in six West Virginia mountain streams. Journal of Environmental Quality. 23 (6): 1271-1279.

Fu, Hailiang; Tajchman, Stanislaw J.; Kochenderfer, James N. 1995. Topography and radiation exchange of a mountainous watershed. Journal of Applied Meteorology. 34 (4): 890-901.

Hornbeck, J.W.; Adams, M.B.; Corbett, E.S.; Verry, E.S.; Lynch, J.A. 1995. A summary of water yield experiments on hardwood forested watersheds in northeastern United States. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 282-295.

Lefohn, Allen S.; Edwards, Pamela J.; Adams, Mary Beth. 1994. The characterization of ozone exposures in rural West Virginia and Virginia. Journal of Air & Waste Management Association. 44: 1276-1283.

Pickens, Callie J.; Sharpe, William E.; Edwards, Pamela J. 1995. The effects of doubling annual N and S deposition on foliage and soil chemistry and growth of Japanese larch (Larix leptolepis Sieb. and Zucc.) in north central West Virginia. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 131-140.

Stephenson, Steven L.; Studlar, Susan Moyle; McQuattie, Carolyn J.; Edwards, Pamela J. 1995. Effects of acidification on bryophyte communities in West Virginia mountain streams. Journal of Environmental Quality. 24 (1): 116-125.

Tajchman, Stanislaw; Fu, Hailiang; Kochenderfer, James N.; Chunshen, Pan. 1995. Spatial characteristics of topography, energy exchange, and forest cover in a central Appalachian watershed. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 297-314.

Extramural

Griffith, Michael B.; Perry, Sue A. 1995. Between-year variation of periphyton community structure in two Appalachian headwater streams. Hydrobiologia. 302: 1-9.

Griffith, Michael B.; Perry, Sue A.; Perry, William B. 1995. Macroinvertebrate communities in headwater streams affected by acidic precipitation in the central Appalachians. Journal of Environmental Quality. 24 (2): 233-238.

Attainment

Progress was made in improving our understanding of hydrology of the Fernow catchments, by quantifying residence times, and through evaluation of long-term effects of forest harvesting.

The effects of acidic deposition on bryophyte communities, aquatic fungi, foliar and soil chemistry, and macroinvertebrate communities were reported. The (unique) watershed acidification study continued for a sixth year. Research showed that tree-ring chemistry did reflect the treatments and that the Fernow watersheds may be nearing nitrogen saturation.

Ozone exposures were characterized for 16 rural sites in West Virginia and Virginia, adding to our ability to evaluate air pollution effects on forests. The spatial characteristics of topography, energy exchange and forest cover were described for watershed 4, the control watershed. This information will be valuable for detailed hydrologic modelling.

Problem 3 **Develop efficient and ecologically sound silvicultural alternatives to complex objectives**
FY 95 Research Attainments

Publications

Research Unit

Miller, Gary W.; Schuler, Thomas M. 1995. A method for applying group selection in central Appalachian hardwoods. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 548. Abstract.

(Poster.)

Miller, Gary W.; Schuler, Thomas M. 1995. Development and quality of reproduction in two-age central Appalachian hardwoods–10-year results. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 364-374.

Miller, Gary W.; Schuler, Thomas M.; Smith, H. Clay. 1995. Method for applying group selection in central Appalachian hardwoods. Res. Pap. NE-696. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 11.

Schuler, Thomas; Miller, Gary W. 1995. Shelterwood treatments fail to establish oak reproduction on mesic forest sites in West Virginia–10-year results. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 375-387.

Smith, H. Clay; Miller, Gary W.; Lamson, Neil I. 1994. Crop-tree release thinning in 65-year old commercial cherry-maple stands (5-year results). Res. Pap. NE-694. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 11.

Smith, H. Clay; Miller, Gary W.; Schuler, Thomas M. 1994. Closure of logging wounds after 10 years. Res. Pap. NE-692. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 6.

Cooperative

Dale, Martin E.; Smith, H. Clay; Pearcy, Jeffrey N. 1995. Size of clearcut opening affects species composition, growth rate, and stand characteristics. Res. Pap. NE-698. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 21.

Attainment

Because forests are dynamic and long-lived, it is important to evaluate silvicultural research over time. This year, 10-year results for several important studies were summarized, and 30-year results of a clearcutting study were reported. Shelterwood treatments did not establish oak reproduction on mesic sites, but favored sweet birch. Two-age hardwood stands exhibited similar species composition, abundance, stem size and quality as stands which had been clearcut. It was also found that some large logging wounds may persist for more than 10 years. The size of clearcut opening was found to significantly affect species composition, growth rate and stand characteristics after 30 years. A method for applying group selection in central Appalachian hardwoods was developed.

Problem 4 **Guidelines for variety of forest management practices and monitoring and mitigation tools**
FY 95 Research Attainments

Publications

Research Unit

Angradi, Ted R.; Vinson, Mark R. 1995. Status of and attitudes toward aquatic macroinvertebrate monitoring on national forests and districts of the Bureau of Land Management. Gen. Tech. Rep. NE-200. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 14.

Baumgras, John E.; LeDoux, Chris B. 1995. Hardwood silviculture and skyline yarding on steep slopes: economic and environmental impacts. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 463-473.

Baumgras, John E.; Sherar, James R.; LeDoux, Chris B. 1995. Environmental impacts from skyline yarding partial cuts in an Appalachian hardwood stand: a case study. In: Hassan, Awatif E.; Sherar, Jim; Swanner, Jack, eds. Sustainability, forest health and meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 87-96.

Edwards, Pamela J.; Owens, Melvin O. 1995. Simple, inexpensive rainfall activation of automatic stream samplers. Stream Tech. Transfer Tips 2. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Station, Stream Systems Technology Center. 4.

Kochenderfer, James N. 1995. Using open-top pipe culverts to control surface water on steep road grades. Gen. Tech. Rep. NE-194. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 7.

Northeastern Forest Experiment Station; West Virginia University Extension Service. 1995. Being a good forest steward. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 25:51 min. Video.

Schuler, Thomas M.; Miller, Gary W.; Smith, H. Clay. 1995. Preliminary guidelines for the use of tree shelters to regenerate northern red oak and other hardwood species on good to excellent growing sites. In: Gottschalk, Kurt W.; Fosbroke, Sandra, L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 573. Abstract.

(Poster.)

Cooperative

Auchmoody, L.R.; Smith, H.C.; Walters, Russell S. 1994. Planting northern red oak acorns: is size and planting depth important? Res. Pap. NE-693. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 5.

Attainment

This problem focuses on guidelines for forest management and methods to monitor effects of forest management. Skyline yarding on steep slopes was evaluated and found to present an alternative to significantly reduce potential environmental impacts associated with logging, although costs were highly variable.

Guidelines were developed for planting acorns, for use of tree shelters to regenerate oaks on good growing sites, and for using open-top pipe culverts to control surface water on steep road grades.

A simple, inexpensive rainfall activator for stream sample collection was developed to improve water quality monitoring. A study of the use of aquatic macroinvertebrates for monitoring land management decisions found that sensitivity to potential impacts was a strength, but that the technique is often not used because of administrative obstacles.

A video, targeting forest landowners, was developed describing how to be a good forest steward.

Problem 5 **Develop methods to reduce safety risks and costs which characterize wood harvesting industry**
FY 95 Research Attainments

Publications

Research Unit

Peters, Penn A.; Erickson, Michael D.; Hassler, Curt D. 1995. Timber marking guidelines to minimize chainsaw felling accidents. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 522. Abstract.

(Poster.)

Peters, Penn A.; Hassler, Curt C.; Erickson, Michael D. 1995. Chain saw felling hazards in partial cuts. In: Hassan, Awatif E.; Sherar, Jim; Swanner, Jack, eds. Sustainability, forest health and meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 249-250. Abstract.

Attainment

The following reflects major accomplishments for the life of this problem. Logging has among the highest fatality rate of any occupation. This situation is worsened by increases in partial cutting. This research resulted in an improved understanding of the causes and nature of "struck by" accidents, in which the victim is hit by a tree, limb, top or snag. Stand geometries which contribute to liklihood of an accident have been described. Timber marking guidelines to minimize chainsaw felling accidents have been developed.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4454

Integrating the Ecological and Social Dimensions of Forest Ecosystem Management

Twery, Mark J., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Methodologies for integrating ecological and social dimensions of forest management	FER	78	.8	2		
2. Application and evaluation of integrated approach to forest management problems.	FPR	603	1.5	3		7
3. To improve mechanisms by which multiple-objective decisions concerning forest ecosystems are made	FPR	226	2.0	4	1	1

Problem 1 **Methodologies for integrating ecological and social dimensions of forest management**
FY 95 Research Attainments

Publications

Research Unit

Tritton, Louise M. 1994. Opening remarks. Panel II. What are the major issues in ecosystem management facing the Northeast? In: McEvoy, Thom J., ed. Ecosystem management: proceedings of a symposium; 1994 July 18-19; Burlington, VT. Burlington, VT: University of Vermont: 23.

(Unit scientist conceived, wrote, presented, and revised manuscript.)

Tritton, Louise M.; Sendak, Paul E. 1995. Ecological aspects of forest management planning: a northern hardwood forest case study. Northern Journal of Applied Forestry. 12 (3): 121-126.

Attainment

We have continued to work with cooperators with expertise in sociology and social ecology. Wetland management is one of the areas in which we have focused on the impacts of current agricultural practices on water quality and explored the changes that could be implemented based on the culture of the people involved. Further work investigating the cultural aspects of forest uses and harvesting of special products is being investigated. The theoretical framework for evaluating biodiversity and the roles of various stakeholders in that evaluation continue to be refined.

Problem 2 **Application and evaluation of integrated approach to forest management problems.**
FY 95 Research Attainments

Publications

Research Unit

Wade, Gary L.; Tritton, Louise M. 1994. Evaluating biodiversity of landscape units with respect to scale, diversity types, and social stakes. In: Science and public policy: program and abstracts, part two: abstracts: 79th annual ESA meeting; 1994 August 7-11; Knoxville, TN. Supplement to Bulletin of the Ecological Society of America. 75(2): 239. Abstract.

Wade, Gary L.; Tritton, Louise M. 1995. Evaluating biodiversity of reclaimed landscape units with respect to scale, diversity types, and social stakes. In: Schuman, Gerald E.; Vance, George F., eds. Decades later: a time for reassessment: proceedings of the 12th annual national meeting of the American Society for Surface Mining and Reclamation; 1995 June 3-8; Gillette, WY; Princeton, WV: American Society for Surface Mining and Reclamation: 836. Abstract.

Wade, Gary L. 1995. Review of "Environmental impacts of mining: monitoring, restoration and control". Restoration Ecology. 3 (1): 68-69.

Cooperative

Alban, Laura Miller; Thomasma, Scott A.; Twery, Mark J. 1995. Forest stewardship planning guide (version 1.00) user's manual [computer program]. Gen. Tech. Rep. NE-203. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 15 p.

(1 computer disk (3-1/2 in.); User's Manual. Unit scientist conceived structure, directed work, and contributed to the writing.)

Bergdahl, D.R.; Bove, J.R.; Sendak, P.E.; Tobi, D.R. 1994. Using a geographic information system to quantify volumes of defect, decay and merchantable wood in diseased sugar maple trees. Phytopathology. 84(10): 1144. Abstract.

(Work unit assisted in research concept, data collection and analyses, and writing of abstract.)

Kollasch, R. Peter; Twery, Mark J. 1995. Object-oriented system design for natural resource decision support: the Northeast Decision Model. AI Applications. 9 (3): 73-84.

(Unit personnel conceived and wrote 100% of the manuscript while affiliated with cooperating unit.)

Palmer, Michael W.; Wade, Gary L.; Neal, Paul. 1995. Standards for the writing of floras. BioScience. 45 (5): 339-345.

(Work unit scientist conceived concept and wrote first two drafts to which coauthors added significant additional material. All authors were fully involved in final version.)

Rauscher, H.M.; Twery, M.; Palmer, J.; Hoffman, R.; Stout, S.; Steinman, J. 1995. Northeast Decision Model design document. AI Applications. 9 (3): 85-86.

(Includes electronic insert (2 disks). The other authors are: Kollasch, P.; Bennett, D.; Thomasma, L.; Hornbeck, J.; Worth, C.V.. Unit authors (3) participated in assembling, writing, and revising material for hypertext document.)

Simpson, Brian T.; Kollasch, R. Peter; Twery, Mark J.; Schuler, Thomas M. 1995. NED/SIPS user's manual: Northeast Decision Model stand inventory processor and simulator (version 1.00) [computer program]. Gen. Tech. Rep. NE-205. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 103 p.

(1 computer disk (3-1/2 in.); User's Manual. Unit personnel directed development of software and shared writing and revision of manuscript.)

Twery, Mark J. 1995. Integrating objectives in ecosystem management with the Northeast Decision Model. In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]:[Publisher name unknown]: 3. Abstract.

(Poster. Manuscript credited to unit where the author was previously affiliated.)

Attainment

In 1995 our biodiversity-related work resulted in publication of Standards for Writing Floras, in which we describe what types of information need to be included and how floras should be organized and maintained in order to answer the question, "How diverse is my land?" We have also published findings relating reclaimed landscapes to diversity and the importance of different aspects of that diversity. Our work on the Northeast Decision Model, now known as NED: a set of decision-support tools for forest ecosystem management has produced two major releases of software tools. First, the Forest Stewardship Planning Guide enables landowners to explore options for managing their forest land for multiple goals across various resources by providing descriptions of conditions needed to meet individual goals and identification of trade-offs if two goals conflict. We anticipate that this program will stimulate dialogue among public and private landowners and forest managers. The second software product, also published with a full user's manual, is NED/SIPS, the Stand Inventory Processor and Simulator. This product is already in use by consulting foresters, state agencies, and others, providing an easy-to-use computer program to summarize inventory data, evaluate costs and revenues of forest operations, and project future stand development. Development of the full NED system of integrated, multiple-resource analysis, prediction, and alternative comparisons is making good progress.

Problem 3 **To improve mechanisms by which multiple-objective decisions concerning forest ecosystems are made**
FY 95 Research Attainments

Publications

Research Unit

Dennis, Donald F. 1995. Techniques for assessing extramarket values. In: Vander Stoep, Gail A., Comp., ed. Proceedings of the 1994 northeastern recreation research symposium; 1994 April 10-12; Saratoga Springs, NY. Gen. Tech. Rep. NE-198. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 143-145.

Dennis, Donald F.; Sendak, Paul E. 1995. Trends in stumpage prices. In: Baggett, Kelly L.; Hannah, Pete, comps. Applied ecosystem management: speakers and abstracts from the 75th annual meeting of the New England Society of American Foresters in cooperation with the Northeastern Forest Pest Council; 1995 March 21-23; Burlington, VT. [Place of publication unknown]: [Publisher name unknown]: 10. Abstract.

(Poster)

Huyler, Neil K.; LeDoux, Chris B. 1995. Estimating the cost of applying Vermont acceptable management practices for logging on moderate slopes. In: Hassan, Awatif E.; Sherar, Jim; Swanner, Jack, eds. Sustainability, forest health and meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 165-171.

Huyler, Neil K.; Williams, Sumner. 1994. Maple syrup production cost–1994 update. Maple Syrup Digest. 6A (3): 10-12.

Cooperative

Sendak, Paul E.; Huyler, Neil K. 1994. Timber management and use-value assessment. Res. Pap. NE-691. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 8 p.

(Work unit scientist conceived part of the study, contributed to writing and compilation of study plan, conducted part of the field data collection and data analyses, and reviewed final manuscript.)

Extramural

McMath, David C. 1994. Literature review and evaluation of methods for determining costs of forest practice regulations on timber harvesting in the Northeast. Burlington, VT: University of Vermont. 58 p. M.S. thesis.

(Work unit provided funding and consultation for this research through a cooperative agreement.)

Attainment

We have made considerable progress in Problem 3, dealing especially with trade-offs among alternatives in evaluating alternative actions while managing forests for multiple values. Central to this topic is the work done in defining techniques for assessing extramarket values. Studies using conjoint analysis, one technique that is especially effective in deriving values indirectly, are underway and producing preliminary results that indicate many different population groups actually hold similar values with regard to benefits from natural resources. Other work under this problem has included relating values from maple syrup production and tree harvesting costs to potential changes in those values as affected by forest practices regulations and tracking trends in stumpage prices.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4455

Northern Stations Global Change Research Program
Birdsey, Richard A., (PM), Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Global Change Research	FPR	1983	1.2	2	36	8
1A. Global Change Research (Continued)	FPR	0	.0	1	30	

Problem 1 **Global Change Research**
FY 95 Research Attainments

Publications

Research Unit

Birdsey, R.A.; Hahn, J.T.; MacLean, C.D.; Arner, S.L.; Bechtold, W.A. 1995. Techniques for forest surveys when cluster plots straddle two or more conditions. Forest Science Monograph. 31: 7-11.

Birdsey, Richard A.; Heath, Linda S. 1995. Carbon storage in U.S. forests. In: Encyclopedia of energy technology and the environment. New York, NY: John Wiley & Sons:

Cooperative

Alexeyev, Vladislav A.; Birdsey, Richard A. 1994. Carbon in ecosystems of forests and peatlands of Russia. Russia: Russian Academy of Sciences, Siberian Branch, V.N. Sukachev Institute. 170.

Carr, Deborah; Donoghue, Linda; Emery, Marla. 1995. Human dimensions of global change research within the USDA Forest Service. In: Proceedings of the 6th symposium on global change studies; 1995 January 15-20; Dallas, TX. Boston, MA: American Meteorological Society: 49-53.

Hanks, Lawrence M.; Paine, Timothy D.; Millar, Jocelyn G.; Hom, John L. 1995. Variation among Eucalyptus species in resistance to eucalyptus longhorned borer in Southern California. Entomologia Experimentalis et Applicata. 74: 185-194.

Ince, Peter J.; Skog, Kenneth E.; Heath, Linda S. 1995. Recycling in the big picture–the really big picture. Resource Recycling. XIV (6): 41-45.

Powell, Douglas S.; McWilliams, William H.; Birdsey, Richard A. 1994. History, change and the U.S. forest inventory. Journal of Forestry. 92 (12): 6-11.

Williams, David W.; Liebhold, Andrew M. 1995. Detection of delayed density dependence: effects of autocorrelation in an exogenous factor. Ecology. 76 (3): 1005-1008.

Williams, David W.; Liebhold, Andrew M. 1995. Forest defoliators and climatic change: potential changes in spatial distribution of outbreaks of western spruce budworm (lepidoptera: Tortricidae) and gypsy moth (Lepidoptera: Lymantriidae). Environmental Entomology. 24 (1): 1-9.

Williams, David W.; Liebhold, Andrew M. 1995. Potential changes in spatial distribution of outbreaks of forest defoliators under climate change. In: Harrington, Richard H.; Stork, Nigel E., comps., eds. Insects in a changing environment: 17th symposium of the Royal Entomological Society. London: Harcourt Brace: 509-513.

Extramural

Boerner, Ralph E.J.; Rebbeck, Joanne. 1995. Decomposition and nitrogen release from leaves of three hardwood species grown under elevated O3 and CO2. Plant and Soil. 170: 149-157.

Boyce, Richard L. 1995. Patterns of foliar injury to red spruce on Whiteface Mountain, New York, during a high-injury winter. Canadian Journal of Forest Research. 25: 166-169.

Carter, Gregory A.; Rebbeck, Joanne; Percy, Kevin E. 1995. Leaf optical properties in Liriodendron tulipifera and Pinus strobus as influenced by increased atmospheric ozone and carbon dioxide. Canadian Journal of Forest Research. 25: 407-412.

Cochard, H.; Ewers, F.W.; Tyree, M.T. 1994. Water relations of a tropical vine-like bamboo (Rhipidocladum racemiflorum): root pressures, vulnerability to cavitation and seasonal changes in embolism. Journal of Experimental Botany. 45: 1085-1089.

Fredericksen, T.S.; Joyce, B.J.; Skelly, J.M.; Steiner, K.C.; Kolb, T.E.; Kouterick, K.B. 1995. Physiology, morphology, and ozone uptake of leaves of black cherry seedlings, saplings, and canopy trees. Environmental Pollution. 89 (3): 273-283.

Gabriel, Katul; Goltz, Stewart M.; Hsieh, Cheng-I.; Mowry, Fred; Sigmon, John. 1995. Estimation of surface heat and momentum fluxes using the flux-variance method above uniform and non-uniform terrian. Boundary-Layer Meteorology. 74: 237-360.

Gentry, Claude E.; Walton, Gerald S.; Davidson, Walter H.; Wade, Gary L. 1994. Influences of humic and fulvic acids and organic matter on leachate chemistry from acid coal spoil. In: Proceedings of international land reclamation and mine drainage conference and third international conference on the abatement of acidic drainage: volume 3: reclamation and revegetation; 1994 April 24-29; Pittsburgh, PA. Bureau of Mines Spec. Publ. SP 06C-94. [Place of publ. unknown): U.S. Department of the Interior, Bureau of Mines: 166-174.

Goldman, Meadow B.; Groffman, Peter M.; Pouyat, Richard V.; McDonnell, Mark J.; Pickett, Steward T.A. 1995. Methane uptake and nitrogen availability in forest soils along an urban to rural gradient. Soil Biology and Biochemistry. 27 (3): 281-286.

Griffith, Michael B.; Perry, Sue A. 1995. Between-year variation of periphyton community structure in two Appalachian headwater streams. Hydrobiologia. 302: 1-9.

Griffith, Michael B.; Perry, Sue A.; Perry, William B. 1995. Macroinvertebrate communities in headwater streams affected by acidic precipitation in the central Appalachians. Journal of Environmental Quality. 24 (2): 233-238.

Groffman, Peter M.; Pouyat, Richard V.; McDonnell, Mark J.; Pickett, Steward T.A.; Zipperer, Wayne C. 1995. Carbon pools and trace gas fluxes in urban forest soils, chapter 13. In: Lal, R.; Kimble, John; Levine, Elissa; Stewart, B.A., comps., eds. Advances in soil science: soil management and greenhouse effect. Boca Raton, FL: CRC Press 147-158:

Hawley, Gary J.; DeHayes, Donald H. 1994. Genetic diversity and population structure of red spruce (Picea rubens). Canadian Journal of Botany. 72 (12): 1778-1786.

Heilman, W.E.; Eenigenburg, J.E.; Main, W.A. 1994. Upper-air synoptic patterns associated with regional fire-weather episodes. In: Proceedings of the 12th international conference on fire and forest meteorology; 1993 October 26-29; Jekyll Island, GA. Bethesda, MD: Society of American Foresters: 355-362.

Holdaway, Margaret R. 1994. In: The microcomputer scientific software series 9: user's guide to Geo-CLM: geostatistical interpolation of the historical climate record in the Lake States. Gen. Tech. Rep. NC-167. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 34.

Johnson, A.H.; Cook, E.R.; Siccama, T.G.; Battles, J.J.; McLaughlin. S.B.; Wargo, P.M. 1995. Comment: synchronic large-scale disturbances and red spruce growth decline. Canadian Journal of Forest Research. 25: 851-858.

Machado, Jose-Luis; Tyree, Melvin T. 1994. Patterns of hydraulic architecture and water relations of two tropical canopy trees with contrasting leaf phenologies: Ochroma pyramidale and Pseudobombax septenatum. Tree Physiology. 14: 219-240.

Miller, Eric K.; Friedland, Andrew J. 1994. Lead migration in forest soils: response to changing atmospheric inputs. Environmental Science & Technology. 28: 662-669.

Nikolov, Nedialko T.; Massman, William J.; Schoettle, Anna W. 1995. Coupling biochemical and biophysical processes at the leaf level: an equilibrium photosynthesis model for leaves of C3 plants. Ecological Modelling. 80: 205-235.

Ollinger, Scott V.; Aber, John D.; Federer, C. Anthony; Lovett, Gary M.; Ellis, Jennifer M. 1995. In: Modeling physical and chemical climate of the northeastern United States for a geographic information system. Gen. Tech. Rep. NE-191. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 30.

Ollinger, Scott V.; Aber, John D.; Lovett, Gary M.; Millham, Sarah E.; Lathrop, Richard G.; Ellis, Jennifer M. 1993. A spatial model of atmospheric deposition for the northeastern U.S. Ecological Applications. 3 (3): 459-472.

Palmer, Michael J.; Wade, Gary L.; Neal, Paul R. 1995. Standards for the writing of floras. BioScience. 45 (5): 339-345.

Patino, Sandra; Tyree Melvin T.; Herre, E. Allen. 1995. Comparison of hydraulic architecture of woody plants of differing phylogeny and growth form with special reference to freestanding and hemi-epiphytic Ficus species from Panama. New Phytologist. 129: 125-134.

Pell, E.J.; Temple, P.J.; Friend, A.L.; Mooney, H.A.; Winner, W.E. 1994. Compensation as a Plant Response to Ozone and Associated Stresses: An Analysis of ROPIS Experiments. Journal of Environmental Quality. 23: 429-436.

Pell, Eva J.; Eckardt, Nancy A.; Glick, Richard E. 1994. Biochemical and molecular basis for impairment of photosynthetic potential. Photosynthesis Research. 39: 453-462.

Pouyat, R.V.; Parmelee, R.W.; Carreiro, M.M. 1994. Environmental effects of forest soil-invertebrate and fungal densities in oak stands along an urban-rural land use gradient. Pedobiologia. 38: 385-399.

Pouyat, Richard V.; Carreiro, M.M.; McDonnell, M.J.; Pickett, S.T.A.; Groffman, P.M.; Zipperer, W.C. 1995. Carbon and nitrogen dynamics in oak stands along an urban-rural gradient. In: McFee, William W.; Kelly, J. Michael, comps., eds. Carbon forms and functions in forest soils. Madison, WI: Soil Science Society of America: 569-587.

(Based on papers presented at the 8th North American forest soils conference, May 1993, Gainesville, FL)

Pouyat, Richard V.; McDonnell, Mark J.; Pickett, S.T.A. 1995. Soil characteristics of oak stands along an urban-rural land-use gradient. Journal of Environmental Quality. 24: 516-526.

Schaberg, P.G.; Wilkinson, R.C.; Shane, J.B.; Donnelly, J.R.; Cali, P.F. 1995. Winter photosynthesis of red spruce from three Vermont seed sources. Tree Physiology. 15: 345-350.

Schulze, E.D.; Schulze, W.; Kelliher, F.M.; Vygodskaya, N.N.; Ziegler, W.; Kobak, H. 1995. Aboveground biomass and nitrogen nutrition in a chronosequence of pristine Dahurian Larix stands in eastern Siberia. Canadian Journal of Forest Research. 25: 943-960.

Smith, J.A.; Goltz, S.M. 1994. Updated thermal model using simplified short-wave radiosity calculations. Sensing of the Environment. 47: 167-175.

Smith, James A.; Goltz, S.M. 1994. A thermal exitance and enery balance model for forest canopies. IEEE Transactions on Geoscience and Remote Sensing. 32 (5): 1060-1066.

Takle, Eugene S.; Bramer, Daniel J.; Heilman, Warren E.; Thompson, Metinka R. 1994. A synoptic climatology for forest fires in the NE US and future implications from GCM simulations. International Journal of Wildland Fire. 4 (4): 217-224.

Thornton, F.C.; Joslin, J.D.; Pier, P.A.; Neufeld, H.; Seiler, J.R.; Hutcherson, J.D. 1994. Cloudwater and ozone effects upon high elevation red spruce: a summary of study results from Whitetop Mountain, Virginia. Journal of Environmental Quality. 23 (6): 1158-1167.

Tobi, Donald R.; Wargo, Philip N.; Bergdahl, Dale R. 1995. Growth response of red spruce after known periods of winter injury. Canadian Journal of Forest Research. 25: 669-681.

Waite, C.E.; DeHayes, D.H.; Rebbeck, J.; Schier, G.A.; Johnson, A.H. 1994. The influence of elevated ozone on freezing tolerance of red spruce seedlings. New Phytologist. 126: 327-335.

Zotz, Gerhard; Tyree, Melvin T.; Cochard, Herve. 1994. Hydraulic architecture, water relations and vulnerability to cavitation of Clusia uvitana Pittier: a C3-CAM tropical hemiepiphyte. New Phytologist. 127: 287-295.

Attainment

The program has sponsored a series of topical workshops on multiple stress physiology, soil carbon modeling, and human dimensions research. The 1995 meeting of the Northern Global Change Program scientists highlighted and summarized the scientific results of the overall program, which were printed and distributed as the 94-95 NGC Program Report and the Meeting Abstracts. The multiple stress physiology research indicated that certain sensitive trees subjected to ozone fumigations interacting with elevated carbon dioxide, showed less growth and greater leaf damage than ozone fumigations alone. These results contradict the generalization that increased carbon dioxide will compensate for the negative effects of ozone.

The results of the multiple stress work and large scale interdisciplinary research on forest health and productivity, has enabled our research program to leverage additional NSF competitive funds to study ecosystem level CO2 X O3 fumigations and forest stand level analysis of carbon flux. The National Carbon Budget model has contributed to policy analysis on carbon sequestration in forests and will be used in refining soil carbon estimates in forested systems in cooperation with other agencies at the regional and national scale.

Our program, with input from external reviewers, program scientists, and research staff, has identified the core areas of research that will be strengthened in preparation for a major regional and national assessment on forest ecosystem response and sustainability to global change factors.

Problem 1A **Global Change Research (Continued)**
FY 95 Research Attainments

Publications

Research Unit

Emery, Marla. 1995. Protecting the New Jersey Pine Barrens: from whom and for whom? In: Miller, E. Willard, ed. 1994 annual meeting of the middle states division of the Association of American Geographers; 1994 October 21-23; New Paltz, NY. Washington, DC: Association of American Geographers: 50-56.

Extramural

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(Poster.)

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Zasada, J.C.; Teclaw, R.M.; Isebrands, J.G.; Buckley, D.S.; Heilman, W.E. 1994. Effects of canopy cover and site preparation on plant succession and microclimate in a hardwood forest in northern Wisconsin. In: Proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 September 11-22; Anchorage, AK. [Place of publ. unknown]: [Publisher name unknown]: 479-480.

Attainment

The program has sponsored a series of topical workshops on multiple stress physiology, soil carbon modeling, and human dimensions research. The 1995 meeting of the Northern Global Change Program scientists highlighted and summarized the scientific results of the overall program, which were printed and distributed as the 94-95 NGC Program Report and the Meeting Abstracts. The multiple stress physiology research indicated that certain sensitive trees subjected to ozone fumigations interacting with elevated carbon dioxide, showed less growth and greater leaf damage than ozone fumigations alone. These results contradict the generalization that increased carbon dioxide will compensate for the negative effects of ozone.

The results of the multiple stress work and large scale interdisciplinary research on forest health and productivity, has enabled our research program to leverage additional NSF competitive funds to study ecosystem level C02 X 03 fumigations and forest stand level analysis of carbon flux. The National Carbon Budget model has contributed to policy analysis on carbon sequestration in forests and will be used in refining soil carbon estimates in forested systems in cooperation with other agencies at the regional and national scale.

Our program with input from external reviewers, program scientists, and research staff, has identified the core areas of research that will be strengthened in preparation for a major regional and national assessment on forest ecosystem response and sustainability to global change factors.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4501

Ecology and Management of Northeastern Hardwood Insect Pests
Montgomery, Michael E., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Knowledge of factors governing susceptibility of trees to defoliation	FPR	119	.2	3	1	4
2. Genetics, physiology and ecology to enhance biorational methods to manage gypsy moth	FPR	297	1.5	7	1	4
3. Reduce likelihood of establishment of Asian race of gypsy moth in North America	FPR	534	2.4	7		1
5. Implement a biological control program to reduce populations of hemlock woolly adelgid	FPR	237	.9	1	2	

Problem 1 **Knowledge of factors governing susceptibility of trees to defoliation**
FY 95 Research Attainments

Publications

Research Unit

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Montgomery, Michael E. 1995. Consequences of the loss of diversity in North American forests from introductions of exotic pests. In: Korpilahti, Eeva; Salonen, Tommi; Oja, Seppo, eds. Caring for the forest: research in a changing world: abstracts of invited papers: IUFRO XX World Congress; 1995 August 6-12; Tampere, Finland. [Place of publication unknown]: Finnish IUFRO World Congress Organizing Committee: 172-173. Abstract.

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Cooperative

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Extramural

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(William E. Wallner, RWU NE-4501, Hamden, CT, is acknowledged for his review of the family Agromyzidae and for providing photographs of some insects of this family. This contribution appears on pages 621-634 of the Handbook.)

Attainment

The influence of site conditions and tree species mixtures was examined under field conditions. Site susceptibility was related to the percentage of preferred species present in both overstory and understory. Some late flushing aspen stands are resistant to establishment of newly hatched larvae but become infested later in the season if oak is mixed with the aspen. Gypsy moth lavae naturally begin wandering and may switch host species when they are half grown. Greater growth occured when larvae spent their first two weeks on red oak and later fed on aspen. The food conversion efficiency on aspen is low, but the relative consumption rate is high and hence insects attain excellent growth on it. Whether a mixed species stand will be more susceptible than a single species stand depends on the timing of the switch and other factors not yet examined. Aspen exhibits much variation between clones in its suitability for gypsy moth and this is related to variation in content of phenolic glycosides. Susceptibility to Bacillus thuringiensis varied 100-fold on different aspen trees and was related to phenolic glycoside content of the foliage.

Problem 2 — Genetics, physiology and ecology to enhance biorational methods to manage gypsy moth
FY 95 Research Attainments

Publications

Research Unit

Keena, Melody A. 1994. Genetics of diapause in the gypsy moth: a review. In: Logan, Jesse A.; ODell, Thomas M.; Gray, David R., eds. Diapause and gypsy moth management: status, applications, and research; 1991 October 2-3; Blacksburg, VA. Gen. Tech. Rep. NE-193. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 89-97.

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ODell, Tom. 1995. Wesson salt problem. Frass Insect Rearing Newsletter. 18 (1): 2-3.

Sanchez, Vicente. 1995. The genetic structure of northeastern populations of the tachinid, Compsilura concinnata Meigen, an introduced parasitoid of exotic forest defoliators of North America. Amherst, MA: University of Massachusetts. 135. Ph.D. dissertation.

(Dissertation entered in electronic database of UMI Dissertation Services, Ann Arbor, MI.)

Shields, K.S.; Podgwaite, J.D. 1995. Effects of nuclear polyhedrosis virus formulations on Lymantria dispar larval peritrophic membrane. In: Bailey, G.W.; Ellisman, M.H.; Hennigar, R.A.; Zaluzec, N.J., eds. Proceedings, Microscopy and Microanalysis 1995. Microscopy Society of America 53rd Annual Meeting; The Histochemical Society 46th Annual Meeting; 1995 August 13-17; Kansas City, MO. Jones & Begell Publishing, New York: 1010-1011. Abstract.

Cooperative

Delfosse, E.S.; Elkinton, J.S.; Fuester, R.W.; Kauffman, W.C.; ODell, T.M. 1995. New directions in biological control of gypsy moth: a collaborative research, technology transfer and implementation plan. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Salem, OR: Oregon Department of Agriculture: 68-73.

Dubois, N.R.; Keena, Melody A. 1995. Potential for development of resistance to Bacillus thuringiensis in treated gypsy moth populations: initial survey. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Salem, OR: Oregon Department of Agriculture: 87-88.

Ferguson, C.S.; Elkinton, J.S.; Gould, J.R.; Wallner, W.E. 1994. Population regulation of gypsy moth (Lepidoptera: Lymantriidae) by parasitoids: does spatial density dependence lead to temporal density dependence? Environmental Entomology. 23 (5): 1155-1164.

Logan, Jesse A.; ODell, Thomas M.; Gray, David R., comps., eds. 1994. Diapause and gypsy moth management status, applications, and research. Gen. Tech. Rep. NE-193. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 97.

Extramural

Gray, David R.; Ravlin, F. William; Regniere, Jacques; Logan, Jesse A. 1995. Further advances toward a model of gypsy moth (Lymantria dispar (L.)) egg phenology: respiration rates and thermal responsiveness during diapause, and age-dependent developmental rates in postdiapause. Journal of Insect Physiology. 41 (3): 247-256.

Attainment

A tachinid fly that parasitizes the gypsy moth was the major source of mortality at low populations. It was found to exhibit a spatially density-dependent response. Aggregation by the parasitoid to patches of high density gypsy moth help to stabilize populations of this pest at low, innocuous densities. The genetic structure of this tachinid (Compsilura concinnata) is very narrow, which may reflect the small gene pool of the founder population. There is some difference in Michigan and New England populations. The diapause of the gypsy moth is extremely complex. Several aspects of this multifaceted problem were discussed at a workshop. Models and information were synthesized to enable better production of egg hatch.

Problem 3 **Reduce likelihood of establishment of Asian race of gypsy moth in North America**
FY 95 Research Attainments

Publications

Research Unit

Keena, M.A. 1994. Identification of gypsy moth larval color forms. NE/NA-INF-123-94. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station and Northeastern Area, State & Private Forestry. 2.

Keena, Melody. 1995. Biological consequences of hybridization between Asian and European gypsy moths. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Salem, OR: Oregon Department of Agriculture: 58-59.

Montgomery, Michael E. 1995. The Asian gypsy moth (Lymantria dispar) an international story of impacts and cooperation. In: Korpilahti, Eeva; Salonen, Tommi; Oja, Seppo, eds. Caring for the forest: research in a changing world: abstracts of invited papers: IUFRO XX World Congress; 1995 August 6-12; Tampere, Finland. [Place of publication unknown]: Finnish IUFRO World Congress Organizing Committee: 185. Abstract.

Wallner, W.E.; Grinberg, P.S.; Walton, G.S. 1994. Differentiation between gypsy moth (Lepidoptera: Lymantriidae) populations by spectral color discrimination of head capsules. Environmental Entomology. 23 (3): 659-664.

Wallner, William E. 1994. What is Asian gypsy moth? In: National Plant Board 68th meeting; 1994 August 7-10; Helena, MT. Chicago, IL: National Plant Board: 75-76.

Wallner, William E.; Charlton, Ralph E.; Carde, Ring T. 1995. Asian gypsy moth adult behavior. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Salem, OR: Oregon Department of Agriculture: 66-67.

Wallner, William E.; Humble, Lee M.; Levin, Robert E.; Baranchikov, Yuri N.; Carde, Ring T. 1995. Response of adult Lymantriid moths to illumination devices in the Russian Far East. Journal of Economic Entomology. 88 (2): 337-342.

Cooperative

Baranchikov, Yu. N.; Vshishkova, T.A.; Montgomery, M.E.; Soldatov, V.V. 1995. Experimental comparison of larval growth and development of European, Asian, and American populations of gypsy moth. Krasnoyarsk, Russia: Russian Academy of Sciences, Siberian Branch, V.N. Sukachev Institute; 26.

(In Russian)

Attainment

The biological consequences of hybridization between gypsy moths of Asian and European origin were examined in the USDA Forest Service Quarantine Laboratory. Findings include: lower diapause requirements of Russian eggs are retained in hybrids; faster larval growth is retained and accelerated with hybridization; the full range of larval color variation is retained in hybrids. Female flight capacity is reduced, but not eliminated; the ability to survive of newly-hatched hybrid larvae resembles more the Asian than the European parents. Field studies of flight behavior of Asian populations in Germany showed that flight periodicity was different than observed in Russia, but the rhythms of attraction to pheromone are similar in German "hybrid" populations and populations in Russia and North America; thus, timing of male attraction is not a barrier to hybridization of global populations. Larval color forms and head capsule color spectra can be used to distinguish Asian from North American gypsy moth.

Problem 5 **Implement a biological control program to reduce populations of hemlock woolly adelgid**
FY 95 Research Attainments

Publications

Research Unit

Lyon, S.M.; Montgomery, M.E. 1995. Scymnus (Pullus) suturalis Thunberg (Coleoptera: Coccinellidae): new locality records, and a report of feeding on hemlock woolly adelgid, Adelges tsugae Annand (Homoptera: Adelgidae). Coleopterists Bulletin. 49 (2): 118.

Extramural

McClure, Mark S. 1995. Managing hemlock-woolly adelgid in ornamental landscapes. Bull. 925. New Haven, CT: Connecticut Agricultural Experiment Station. 3-7.

McClure, Mark S. 1995. Using natural enemies from Japan to control hemlock woolly adelgid. Frontiers of Plant Science. 47 (2): 5-7.

Attainment

The hemlock woolly adelgid (HWA) is turning the hemlocks from southern New England to Virginia into gray ghosts. Research is just underway to establish biological controls and increase the resistance of hemlock to this exotic pest. A coccinellid beetle, Scymnus suturalis, was found feeding on Adelges tsugae. This predator was introduced to North America several years ago and is frequently found on Scots pine. It sometimes is very abundant on A. tsugae, but its ecological host range seems to favor adelgids in the genus Pineus. Predators were imported from Japan and released in Connecticut. These are an orbatid mite that feeds on the woolly wax that covers and protects hemlock woolly adelgid eggs, and a lady beetle, Pseudoscymnus new sp. An exploratory visit to China was made and another species of lady beetle was abundant there. A small number of these were imported to the USDA Forest Service Quarantine Laboratory for rearing, identification, and evaluation.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4502

Pathology and Microbial Control of Insects Defoliating Eastern Forest Trees

McManus, Michael L., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Develop the technology needed to optimize use of Bt to protect forests from defoliating insects	FPR	229	1.2	2	2	1
2. Improve production, enhance activity, and optimize appli. of GYPCHEK against gypsy moth	FPR	306	1.0	2		1
3. Effect of Bt application on distribution and abundance of non-target Lepidoptera in forests	FPR	141	1.0	1	2	1
4. Introduce/establish exotic pathogens i.e. microsporidia to enhance natural control of GM	FPR	129	.6	1		1
M1. Develop and evaluate integrated pest management (IPM) strategies to manage the gypsy moth	FPR	0	.1	1	3	1

Problem 1 **Develop the technology needed to optimize use of Bt to protect forests from defoliating insects**
FY 95 Research Attainments

Publications

Research Unit

Dubois, N.R.; Keena, Melody A. 1995. Potential for development of resistance to Bacillus thuringiensis in treated gypsy moth populations: initial survey. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Salem, Oregon: Oregon Department of Agriculture: 87-88.

Dubois, Normand R.; Keena, Melody A. 1995. Analysis of the effect of repeated treatments of Bacillus thuringiensis on gypsy moth populations. In: Program and abstracts: 28th annual meeting of the Society for Invertebrate Pathology; 1995 July 16-21; Ithaca, NY. Newark, NJ: Society for Invertebrate Pathology: 16-17. Abstract.

Cooperative

Miller, David R.; Yang, Ziusheng; McManus, Michael A. [L.]. 1994. Effects of micrometeorology on aerial spray application of pesticides to hardwood forest canopies. In: Maarouf, A.R.; Barthakur, N.N.; Haufe, W.O., eds. Biometeorology, part 2, volume 1: proceedings of the 13th international congress of biometeorology; 1993 September 12-18; Calgary, AB. Downsview, ON: Environment Canada: 261-273.

Extramural

Maczuga, Steve. 1995. A windows based program which predicts gypsy moth larval mortality from field deposits of undiluted Foray 48B on oak foliage. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Oregon Department of Agriculture, Salem, Oregon: 89. Abstract.

Mierzejewski, Karl. 1995. Differentially corrected GPS navigation systems for aerial spraying in forestry. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. Salem, Oregon: Oregon Department of Agriculture: 39-42.

Attainment

Development of resistance to Bacillus thuringiensis Bt in insect populations is of major concern; two of 8 pest species that demonstrated resistance to Bt under selection pressure in laboratory studies also exhibited resistance after repeated applications in operational programs. Consequently, there is major concern about the potential for development of resistance to Bt in gypsy moth (GM) populations, since Bt is the pesticide of choice against this pest. First generation progenies were analyzed from wild populations that had been repeatedly treated with Bt and shown to be as susceptible as the wild untreated population. Results to date suggest that unselected progenies and progenies selected from a LC75 dose also fail to show any sign of development of resistance to Bt. The susceptibility of the Asian strain of GM introduced from Russia through the pacific northwest and into North Carolina from Germany were shown to be as susceptible as the North American (NA) strain. Recently, four Asian strains from China and strains from Japan, Poland and Lithuania were also found to be as susceptible as the NA strain. Preliminary analysis of hybrids with NA strains show some reduction in susceptibility to Bt. Degradation of Bt by UVB-1 radiation on oak seedlings showed that the half life of Bt (a) is 16-30 hrs. when exposed to full sun; (b) can be days in partial (33%) shade and (c) exceeds 5 days if not exposed to the sun. There may be stronger relationship between time of initial exposure (early AM midday or PM) and the onset of degradation than on the total cumulative radiation.

Problem 2 **Improve production, enhance activity, and optimize appli. of GYPCHEK against gypsy moth**
FY 95 Research Attainments

Publications

Research Unit

Shields, K.S.; Podgwaite, J.D. 1995. Effects of nuclear polyhedrosis virus formulations on Lymantria dispar Larval peritrophic membrane. In: Bailey, G.W.; Ellisman, M.H.; Hennigar, R.A.; Zaluzec, N.J., eds. Proceedings, Microscopy and Microanalysis 1995. Microscopy Society of American 53rd Annual Meeting; The Histochemical Society 46th Annual Meeting; 1995 August 13-17; Kansas City, MO. Jones & Begell Publishing, New York: 1010-1011. Abstract.

Podgwaite, John D.; Reardon, R.C. 1995. Gypchek: where we've been..where we're going. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. [Place of publ. unknown]: National Gypsy Moth Management Board: 168-169.

Cooperative

D'Amico, Vincent; Elkinton, Joseph S.; Wood, H. Alan; Podgwaite, John D.; McManus, Michael L.; Slavicek, James; Burand, John P. 1994. A field test of genetically engineered gypsy moth NPV. In: Kelley, Ronald S., comp. Proceedings of the combined meeting of the Northeastern Forest Pest Council and the 26th annual northeastern forest insect work conference; 1994 March 21-23; Manchester, NH. [Place of publication unknown]: [Publisher name unknown]: 14. Abstract.

Attainment

In bioassays, the viral pesticide Gypchek was found to be nearly twice as virulent against Asian gypsy moth larvae from China when compared to the standard New Jersey laboratory strain. This information is critical for establishing efficaceous doses of Gypchek for either suppression or eradication of Asian strains in the U.S. Further, there is much interest in the use of Gypchek in foreign countries in which Asian strains are now, or likely to be established. Bioassays of genetically distinct viral variants from Gypchek have identified strains of enhanced potency that will be more cost-effective for in-vivo production and adaptable to large-scale in vitro production. RWU personnel continue to produce Gypchek in the absence of a commercial partner. In 1995 more than 3,000 acres were treated in suppression and eradication programs. A ready-to-use Gypchek spray-adjuvant, developed in cooperation with Novo Nordisk, Inc., was field-tested after extensive laboratory and field-simulated spray-tower feasibility trials. Results of the aerial field-test indicate that the new spray-adjuvant is superior to previous formulations in ease-of-use, droplet deposition characteristics, and resistance to ultraviolet degradation. Further, results show the adjuvant is as effective at a reduced volume of spray and in a single application. Results of Gypchek studies have been reported to various work conferences, research forums and scientific meetings. This microbial pesticide is extremely compatible with forest protection and ecosystem management initiatives because of its efficacy, specificity and safety against on-target organisms.

Problem 3 **Effect of Bt application on distribution and abundance of non-target Lepidoptera in forests**
FY 95 Research Attainments

Publications

Research Unit

McManus, Michael L. 1994. Impacts of gypsy moth defoliation on forest ecosystems vs. impacts of protecting foliage with pesticides: the need to balance the equation. In: Kelley, Ronald S., comp. Proceedings of the combined meeting of the Northeastern Forest Pest Council and the 26th annual northeastern forest insect work conference; 1994 March 21-23; Manchester, NH. [Place of publ. unknown]: [Publisher name unknown]: 31-32.

Cooperative

Wagner, David L.; Peacock, John W.; Carter, Jane L.; Talley, Steve E. 1995. Spring caterpillar fauna of oak and blueberry in a Virginia deciduous forest. Annals of the Entomological Society of America. 88 (4): 416-426.

Extramural

Reardon, R.C.; Wagner, D.L. 1995. Impact of Bacillus thuringiensis on non-target Lepidopteran species in broad-leaved forests: chapter 21. In: Hall, Franklin R.; Barry, John W., eds. Biorational pest control agents: formulation and delivery. ACS Symp. Ser. 595. Washington, DC: American Chemical Society: 284-292.

Wagner, David; Miller, Jeffrey C. 1995. Must butterflies die for the gypsy moths' sins? American Butterflies. Fall: 19-23.

Attainment

Manuscripts for field and laboratory studies initiated in 1991 to evaluate the effects of a single application of Bacillus thuringiensis (Bt) on non-target Lepidoptera are being prepared. Laboratory studies concluded that 27 of 42 species were susceptible although no trends appeared among families, genera, or species. Field studies that employed both burlap banding and foliage sampling showed that a treatment effect did occur but that most species appeared to recover in the year following treatment. Results from light trapping studies were less conclusive, however, these collections provided us with an excellent record of the biodiversity of Lepidoptera in a mixed-oak ecosystem; over 600 species have been identified from the collections. Additional laboratory bioassays were conducted in 1995 to evaluate the effects of two applications of Bt on moderately sensitive or insensitive species. Results from the six species assayed showed that a second application of Bt caused no significant increase in mortality. Field studies to evaluate the effects of two applications of Bt and gypsy moth defoliation on non-target Lepidoptera were conducted in West Virginia from May through July, 1995. Eighty to 100 trees were burlapped in five sprayed plots, five plots with high gypsy moth densities (expected defoliation), and five plots with low gypsy moth densities (control plots). Data are being analyzed.

Problem 4 **Introduce/establish exotic pathogens i.e. microsporidia to enhance natural control of GM**
FY 95 Research Attainments

Publications

Research Unit

McManus, Michael L.; Maddox, Joseph V. 1995. Microsporidian pathogens of the gypsy moth: their distribution in Europe and significance in biological control. In: Korpilahti, Eeva; Salonen, Tommi; Oja, Seppo, eds. Caring for the forest: research in a changing world: abstracts of invited papers: IUFRO XX World Congress; 1995 August 6-12; Tampere Finland. [Place of publication unknown]: Finnish IUFRO World Congress Organizing Committee: 92. Abstract.

Cooperative

Maddox, J.V.; Baker, M.D.; McManus, M.L.; Solter, L.F.; Vossbrinck, C.R. 1995. Taxonomic and ecological considerations for ten different microsporidia isolated from european gypsy moths. In: Program and abstracts: 28th annual meeting of the Society for Invertebrate Pathology; 1995 July 16-21; Ithaca, NY. Newark, NJ: Society for Invertebrate Pathology: 40-41. Abstract.

Attainment

A scientific exchange with the Bulgarian Academy of Sciences has provided us with yet another microsporidian pathogen of the gypsy moth. Over the past three years, we have recovered 8 new isolates from gypsy moth populations in Europe through foreign exploration. Most of these are new species which must be described and then evaluated as to their potential for classical biocontrol of the gypsy moth in North America. During the process of evaluating these isolates against 40-50 species of non-target forest lepidoptera, we have concluded that the response of non-target larvae when challenged with these exotic microsporida can be grouped into three categories: no effect (refractory); light and/or typical infections; heavy infections identical to those that occur in gypsy moth larvae. To date, few of the isolates have produced heavy infections in non-target lepidoptera larvae. Field studies have been initiated in Slovakia in 1995 to evaluate the prevalence of microsporidia in gypsy moth larval populations at low and high density levels. These studies are being funded by an FAS/ICD International Collaborative Research Project and will continue for a period of three years.

Problem M1 **Develop and evaluate integrated pest management (IPM) strategies to manage the gypsy moth**
FY 95 Research Attainments

Publications

Research Unit

Carter, Jane L.; Ravlin, F. William. 1995. Evaluation of binomial egg mass sampling plans for low density gypsy moth populations in continuously forested habitats. Journal of Economic Entomology. 88 (4): 890-896.

Cooperative

Liebhold, A.M.; Elkinton, J.S.; Zhou G.; Hohn M.E.; Rossi, R.E.; Boettner, C.W. 1995. Regional correlation of gypsy moth (Lepidoptera: Lymantriidae) defoliation with counts of egg masses, pupae, and male moths. Environmental Entomology. 24 (2): 193-203.

(McManus, M.L., NE-4502 is also a co-author)

Extramural

Gray, David R. 1995. The use of respiration rate in the examination of gypsy moth egg development and diapause. In: Logan, Jesse A.; ODell, Thomas M.; Gray, David R., eds. Diapause and gypsy moth management: status, applications and research. Gen. Tech. Rep. NE-193. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 60-72.

Gray, David R.; Ravlin, F. William; Regniere, Jacques; Logan, Jesse A. 1995. Further advances toward a model of gypsy moth (Lymantria dispar (L.)) egg phenology: respiration rates and thermal responsiveness during diapause, and age-dependent developmental rates in postdiapause. Journal of Insect Physiology. 41 (3): 247-256.

Prendergast, B.F.; Yendol, W.G.; Maczuga, S.; Reardon, R.C.; McLane, W.H.; Miller, D.R. 1995. Diflubenzuron residue and persistence on an oak forest after aerial application. Journal of Environmental Science and Health. B30 (3): 359-376.

Attainment

Recent introductions of the Asian strain of the gypsy moth into North America and resultant programs to eradicate these infestations have emphasized the importance of our being able to predict when phenological events such as egg hatch of this alien species may occur. Furthermore, the timing of activities related to the development of the gypsy moth is related to the onset of eclosion. To this end, a three-phase model of gypsy moth egg development has been developed utilizing the measurement of respiration rates of individual embryos during different stages of diapause. Preliminary evaluations suggest that this model is a much better predictor of egg hatch than earlier models that did not distinguish between diapause and postdiapause requirements related to temperature. Efforts continue to determine the most efficient method for sampling gypsy moth egg masses at low density levels (less than 250 egg masses/hectare) since the decision to treat populations is commonly based on estimates of population density within this range. A recently completed study concludes that fixed and variable-radius plot sampling was more efficient than binomial sampling plans in estimating the density of sparse populations.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4505

Etiology, Epidemiology and Physiology of Stress-Regulated Host-Pest Interactions (Stress-Triggered Tree Diseases)

Wargo, Philip M., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. We lack critical infor. on role of disease causing organisms in stress initiated disease	FPR	422	.8	3		4
2. We need to understand genetic makeup and pathogenic capabilities of pest populations	FPR	49	.2			
3. We need to develop understanding of how forest management practices interact with stress	FPR	148	.9			2

Problem 1 **We lack critical infor. on role of disease causing organisms in stress initiated disease**
FY 95 Research Attainments

Publications

Research Unit

Houston, D.R. 1994. Major new tree disease epidemics: beech bark disease. Annual Review of Phytopathology. 32: 75-87.

Houston, David R. 1994. Beech bark disease. In: Kelley, Ronald S., comp. Proceedings of the combined meeting of the Northeastern Forest Pest Council and the 26th annual northeastern forest insect work conference; 1994 March 21-23; Manchester, NH. [Place of publ. unknown]: [Publisher name unknown]: 35-36.

Wargo, Philip M. 1994. Decline diseases: barometer or cause of change in forest health. In: Kelley, Ronald S., comp. Proceedings of the combined meeting of the Northeastern Forest Pest Council and the 26th annual northeastern forest insect work conference; 1994 March 21-23; Manchester, NH. [Place of publ. unknown]: [Publisher name unknown]: 33.

Cooperative

Houston, D.B.; Houston, D.R. 1994. Variation in American beech (Fagus grandifolia Ehrh.): isozyme analysis of genetic structure in selected stands. Silvae Genetica. 43 (5/6): 277-284.

(Evaluates the genetic makeup of beech stands and their susceptibility to the beech scale insect and subsequently to the Nectria fungi.)

Johnson, A.H.; Cook, E.R.; Siccama, T.G.; Battles, J.J.; McLaughlin, S.B.; Wargo, P.M. 1995. Comment: synchronic large-scale disturbances and red spruce growth decline. Canadian Journal of Forest Research. 25: 851-858.

(This publication was prepared in response to a series of articles claiming that decreases in radial growth of red spruce were related to changes in forest competition rather than crown deterioration.)

Muzika, Rose-Marie; Wargo, Philip M. 1994. Oak decline and mortality. In: Kelley, Ronald S., comp. Proceedings of the combined meeting of the Northeastern Forest Pest Council and the 26th annual northeastern forest insect work conference; 1994 March 21-23; Manchester, NH. [Place of publ. unknown]: [Publisher name unknown]: 36.

Tobi, Donald R.; Wargo, Philip M.; Bergdahl, Dale R. 1995. Growth response of red spruce after known periods of winter injury. Canadian Journal of Forest Research. 25: 669-681.

(First report substantiating the adverse effects of winter injury on radial and terminal growth of red spruce.)

Attainment

Red Spruce Decline: Studies on fine root vitality and acidic deposition initiated in 1992 under the Global Change Program on the relationship of root biomass, turnover, and chemistry, mycorrhizal relationships, and fine root pathology with soil chemistry continue. Root systems were sampled again in 1994. Measurements of fine root mortality, mycorrhizal status and carbohydrate and phenol chemistry were repeated and data are being compiled to verify trends identified in earlier samples. Measurements of carbon sequestering in mineral soil in red spruce plots that have been fertilized for three consecutive years with Ca and N show that N fertilization increased the level of carbon in these soils. Publication to Nature (Coop. K. Vogt, Yale Univ.). Fertilization has also had an effect on litter deposition causing an increase on all Ca treated plots.

Biocontrol of beech scale: Preliminary trials to determine if the fungus, Verticillium lecanii, is pathogenic to beech scale will be evaluated this autumn. Isolates of V. lecanii have been shown to markedly reduce high populations of beech scale on European beech in Great Britain. Coop. B. Parker and M. Brownbridge, Univ. VT).

Problem 2 **We need to understand genetic makeup and pathogenic capabilities of pest populations**
FY 95 Research Attainments

Publications

none

Attainment

Beech Bark Disease: Publication on population genetics studies comparing RFLP's of nuclear and mitochondrial DNA of the two Nectria fungus species associated with beech bark disease that show Nectria galligena, a native pathogen causing cankers on many associated tree species, is more variable than N. coccinea var. faginata, an introduced fungus, are prepared and will be submitted this autumn to Can. J. For. Res.

Armillaria: Data suggest that significant levels of genetic recombination by pairing of haploid myceliums are occurring or have occurred in these plots. Three species of Armillaria have thus far been identified by cultural techniques, Armillaria gallica, A. calvescens, and A. mellea. A. gallica is most abundant.

Problem 3 **We need to develop understanding of how forest management practices interact with stress**
FY 95 Research Attainments

Publications

Cooperative

Barker, M.J.; Skilling, D.D.; Houston, D.R.; Ostry, M.E. 1995. Propagation of American beech with resistance to beech bark disease. 1995 American Phytopathological Society annual meeting; 1995 August 12-16; Pittsburgh, PA. St. Paul, MN: American Phytopathological Society. Poster.

Burrill, E.A.; Worrall, J.J.; Wargo, P.M. 1994. Effects of thinning and defoliation on Armillaria and a potential antagonist. Phytopathology. 84: 1106. Abstract.

Attainment

Armillaria: The relationship of Armillaria and a competitor, Megacollybia (Tricholomopsis) platyphylla was investigated in cut and defoliated stands. M. platyphylla colonized more substrate than Armillaria in all stands while Armillaria colonized more substrates in defoliated than in thinned and defoliated stands, suggesting that cutting and M. Platyphylla can mitigate colonization of available substrate by Armillaria. Publication prepared for Can. J. For. Res. (Coop. J. Worrall and L. Burrill, SUNY).

Beech Bark Disease: The final measurement of sprouting response around cut and standing, resistant and susceptible beech trees following different harvest regimes was made in 12, 10-acre stands in Maine.

Sugar maple - effects of paraformaldehyde (P): Significantly more tapholes (60-75%) treated with P had decay, while only 25% of nontreated tapholes had decay. Decay columns and columns of discoloration associated with tapholes continued to increase in size over time. Those columns in P-treated tapholes were larger than around nontreated tapholes and the difference between P-treated and non-P treated increased over time. In most cases, flushing tapholes with water when the spouts were pulled increased the incidence and size of the columns about the tapholes. In P-treated tapholes but not in controls, volume of decay was greatest when tapping was done prior to and well after onset of sapflow. Paper will be prepared as Station publication.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4509

Development of Biologically Based Controls for Forest Insect Pests and Diseases Through Molecular Technologies

Slavicek, James M., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Fundamental development of biological agents and biorational approaches for insect control	FPR	611	2.9	20	4	
2. Develop biological and biorational approaches for control of tree diseases	FPR	601	1.8	4		
3. Use of biotechnology to generate solutions to problems supporting current research	FPR	13	.3	3		

Problem 1 **Fundamental development of biological agents and biorational approaches for insect control**
FY 95 Research Attainments

Publications

Research Unit

Bischoff, D.S.; Slavicek, J.M. 1994. Identification of the 25K gene of the Lymantria dispar nuclear polyhedrosis virus. In: Applications of biotechnology to tree culture, protection and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 54. Abstract.

Bischoff, D.S.; Slavicek, J.M. 1995. Analysis of mutations in the 25K FP gene in Lymantria dispar MNPV few polyhedra (FP) mutants. In: Scientific program and abstracts: 14th annual meeting of the American Society for Virology; 1995 July 8-12; Austin, TX. [Place of publication unknown]: American Society for Virology: 149. Abstract.

Bischoff, Dave; Flaherty, Kim; Hensel, Dana; Mercer, Melissa; Hayes-Plazolles, Nancy; Slavicek, James. 1994. Identification of five mutant loci that generate a few polyhedra phenotype in the Lymantria dispar multinucleocapsid nuclear polyhedrosis virus. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 7. Abstract.

Bischoff, David S.; Hensel, Dana; Mercer, Melissa; Kelly, Mary Ellen; Slavicek, James M. 1995. Identification of a novel genomic locus in the Lymantria dispar MNPV that affects polyhedron formation and virion occlusion. In: Program and abstracts: 28th annual meeting of the Society for Invertebrate Pathology; 1995 July 16-21; Ithaca, NY. Newark, NJ: Society for Invertebrate Pathology: 7. Abstract.

Bischoff, David S.; Riegel, Christopher I.; Slavicek, James M. 1994. Sequence characterization and temporal expression of the Lymantria dispar nuclear polyhedrosis virus immediate-early gene G22. In: Application of biotechnology to tree culture, protection, and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 55. Abstract.

Bischoff, David S.; Slavicek, James M. 1995. Identification of a Lymantria dispar MNPV gene with homology to the viral enhancing factor gene of Trichoplusia ni granulosis virus. In: Program and abstracts: 28th annual meeting of the Society for Invertebrate Pathology; 1995 July 16-21; Ithaca, NY. Newark, NJ: Society for Invertebrate Pathology: 7-8. Abstract.

Bowers, Diana F.; Valaitis, Algimantas P. 1994. Gas chromatography/mass spectrometry carbohydrate analysis of gypsy moth trehalase. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 10. Abstract.

D'Amico, Vincent; Elkinton, Joseph S.; Wood, H. Alan; Podgwaite, John D.; McManus, Michael L.; Slavicek, James M.; Burand, John P. 1994. A field test of genetically engineered gypsy moth NPV. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 16. Abstract.

Hiremath, S.T.; Podila, G.K. 1994. Biological control of white grubs by genetically-engineered ectomycorrhizal fungi. In: Applications of biotechnology to tree culture, protection, and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 68-69. Abstract.

Hiremath, Shiv; Lehtoma, Kirsten. 1994. Cloning and characterization of a cDNA encoding the small subunit of the vitellogenin from the gypsy moth. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 29. Abstract.

Hiremath, Shiv; Lehtoma, Kirsten. 1994. Genetic control of the gypsy moth. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 30. Abstract.

Mercer, Melissa; Kelly, Mary Ellen; Slavicek, James. 1994. Characterization of a Lymantria dispar multinucleocapsid nuclear polyhedrosis virus variant that exhibits enhanced polyhedra production stability during serial passage in cell culture. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 53. Abstract.

Riegel, Christopher; Park, Eun Ju; Burand, John; Slavicek, James M. 1994. Deletion of the Lymantria dispar multinucleocapsid nuclear polyhedrosis virus egt gene enhances viral killing speed. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 70-71. Abstract.

Riegel, Christopher I.; Slavicek, James M. 1994. Characterization of temporal gene expression and DNA replication of the Lymantria dispar multinucleocapsid nuclear polyhedrosis virus. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-189. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 71. Abstract.

Slavicek, J.M.; Bischoff, D.S. 1995. Identification and characterization of an early gene in the LdMNPV. Scientific program and abstracts: 14th annual meeting of the American Society for Virology; 1995 July 8-12; Austin, TX. [Place of publication unknown]: American Society for Virology: 160. Abstract.

Slavicek, J.M.; Mercer, M.J., inventors. The United States of America as represented by the Secretary of Agriculture, assignee. Gypsy moth virus with enhanced polyhedra production stability. U.S. patent 5,420,031. 1995 May 30. Int. C16 A01N 63/00; C12N 7/00. U.S. Cl. 435/235.1.

Slavicek, James M.; Hayes-Plazolles, Nancy; Kelly, Mary Ellen. 1995. Rapid formation of few polyhedra mutants of Lymantria dispar multinucleocapsid nuclear polyhedrosis virus during serial passage in cell culture. Biological Control. 5: 251-261.

Valaitis, Algimantas P. 1994. Characterization of the midgut proteinases of gypsy moth larvae. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-189. Radnor, PA; U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 82. Abstract.

Valaitis, Algimantas P. 1994. Effects of proteinase inhibitors on midgut proteinase and the growth and development of gypsy moth larvae. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 83. Abstract.

Valaitis, Algimantas P. 1995. Gypsy moth midgut proteinases: purification and characterization of luminal trypsin, elastase and the brush border membrane leucine aminopeptidase. Insect Biochemistry and Molecular Biology. 25 (1): 139-149.

Extramural

Theim, S.M.; Du, X.; Quentin, M.E. 1995. Characterization of a gene isolated from LdMNPV that alters the host range of AcMNPV. In: Scientific program and abstracts: 14th annual meeting of the American Society for Virology; 1995 July 8-12; Austin, TX. [Place of publication unknown]: American Society for Virology: 196. Abstract.

Thiem, Suzanne M.; Cassar, Steven C. 1995. Identification and nucleotide sequence of the Lymantria dispar nuclear polyhedrosis virus fusolin homologue and its placement among reported fusolin-like genes. In: Programs and abstracts: 28th annual meeting of the Society for Invertebrate Pathology; 1995 July 16-21; Ithaca, NY. Newark, NJ: Society for Invertebrate Pathology: 60. Abstract.

Thiem, Suzanne M.; Du, Xianlin; Quentin, Martha E. 1995. Characterization of an LdMNPV host range gene. In: Program and abstracts: 28th annual meeting of the Society for Invertebrate Pathology; 1995 July 16-21; Ithaca, NY. Newark, NJ: Society for Invertebrate Pathology: 60-61. Abstract.

Thiem, Suzanne M.; Quentin, Martha E.; Chen, Chi-Ju; Berner, Michelle L. 1994. Mapping a Lymantria dispar M nuclear polyhedrosis virus gene required for replication of Autographa californica M nuclear polyhedrosis virus in a gypsy moth cell line. In: Proceedings, U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 76-77. Abstract.

Attainment

Gypsy moth virus research: A strain of the Lymantria dispar M nuclear polyhedrosis virus (LdMNPV) was developed that exhibits enhanced polyhedra production stability during viral production in cell culture. This viral strain was patented. Polyhedra production attributes of several polyhedron formation LdMNPV mutants were characterized. The elucidation of the function of the muted genes that are responsible for the abnormal polyhedron formation phenotype of these viral mutants may lead to development of viral strains with improved polyhedron production characteristics. Bacillus thuringiensis research: Bt has been used for more than two decades for pest control with continuing success. After activation by insect gut proteases, Bt binds to specific receptors in susceptible insects. The receptors are important determinants for insecticidal activity. Aminopeptidase-N (AP-N) was purified from gypsy moth larvae and identified as the unique receptor for the Bt toxin, CryIA(c). CryIA toxins were shown to induce a rapid release of the membrane-bound AP-N in vivo. Elucidation of the mechanism of Bt action may be valuable for improving the efficacy of Bt products. Insect hormone research: The gene encoding vitellogenin, precursor of a developmentally-regulated, female-specific egg yolk protein in the gypsy moth, was isolated. Determination of the nucleotide sequence of the clone has identified the gene regulatory sequences, which will be utilized to examine the mechanism of hormonal regulation of growth, development and reproduction. White grub control: Ectomycorrhizal fungi associated with pine roots were genetically engineered by inserting the insecticidal BtCryIIIA gene. Effectiveness of the recombinant fungi as biological control agents against white grubs is being evaluated.

Problem 2 **Develop biological and biorational approaches for control of tree diseases**
FY 95 Research Attainments

Publications

Research Unit

Eshita, S.M.; Koch, J.L.; Kamalay, J.C.; Schreiber, L.R. 1994. Isolation and characterization of xylem proteins from American elm (Ulmus Americana L.) inoculated with Dutch elm disease fungus Ophiostoma Ulmi. In: Applications of biotechnology to tree culture, protection and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 28-29. Abstract.

Eshita, Steven M.; Koch, Jennifer L.; Kamalay, Joseph C.; Schreiber, Lawrence R. 1995. Host responses of American elm to Dutch elm disease fungus. In: Journal of Cellular Biochemistry Supplement 19B: 152. Abstract.

Gingas, V.M.; Kamalay, J.C. 1994. Optimization of elm suspension cultures for elicitor/phytoalexin experiments. In: Applications of biotechnology to tree culture, protection, and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 62. Abstract.

Kamalay, J.C.; Carey, D.W.; Schreiber, L.R.; Cheng, Z.M. 1994. Genetic diversity in American elms (Ulmus Americana L.). In: Applications of biotechnology to tree culture, protection, and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 71-72. Abstract.

Attainment

Dutch elm disease research: Xylem proteins induced in susceptible American elms in response to inoculation with Ophiostoma ulmi (the Dutch elm disease fungus) were used in searches for potential American elm pathogenesis-related (PR) genes. N-terminal sequences were used to construct DNA probes for polymerase chain reactions. Amplified DNAs of reasonable size for the coded proteins were isolated and partially sequenced. Sequences were screened for matching codons in adjacent regions of the protein sequence and for relatedness to other sequences in existing databases. Studies involving American elm xylem proteins and genes have been expanded to include a selection of moderate resistance, Delaware 3, to complement research on the susceptible selection. American elm trees were acquired from the closed ARS/National Arboretum project and were typed through DNA fingerprint analysis. Previously initiated tree breeding experiments were continued through the establishment of field plots containing 500 progeny. These trees will be used for evaluation of DED resistance in 1999. Studies were initiated to elicit defense responses from elm suspension cell cultures as an in vitro system for Dutch elm disease research. Research to develop an American elm in vitro regeneration system is being continued.

Problem 3 **Use of biotechnology to generate solutions to problems supporting current research**
FY 95 Research Attainments

Publications

Research Unit

Garner, Karen J.; Slavicek, James M. 1994. A nuclear DNA-based method for identifying Asian gypsy moths and Asian/North American gypsy moth hybrids. In: Proceedings, U.S. Department of Agriculture interagency gypsy moth research forum 1994; 1994 January 18-21; Annapolis, MD. Gen. Tech. Rep. NE-188. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 23. Abstract.

Koch, J.L.; Eshita, S.M.; Wilson, A.D. 1994. Development of PCR-based assays to detect Ceratocystis fagacearum at the species and strain levels. 1994. In: Applications of biotechnology to tree culture, protection and utilization: proceedings of papers presented at the 2nd international symposium; 1994 October 2-6; Bloomington, MN. Gen. Tech. Rep. NC-175. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 75-76. Abstract.

Slavicek, James M.; Schreiber, David E.; Garner, Karen. 1994. Identification of nuclear DNA markers for use in diagnostic assays to differentiate the Asian and North American strains of the gypsy moth. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. [Place of publication unknown]: National Gypsy Moth Management Board: 64-65. Abstract.

Attainment

Oak wilt disease research: Detection of Ceratocystis fagacearum (the oak wilt fungus) at the species level through polymerase chain reaction amplification is being tested with primers designed using a species-unique sequence from the large subunit ribosomal DNA gene. Amplification of C. fagacearum DNA has been successful at levels representing approximately five spores and may be extendable down to single spore detection levels. The effects of insect DNAs and tissues on amplification efficiency are being investigated, as are rapid microwave DNA preparation techniques for insect and fungus samples.

Asian Gypsy Moth research: Nuclear DNA markers for use is distinguishing the Asian and North American gypsy moth strains were developed. These markers are being used by the Animal and Plant Health Inspection Service, Agriculture Canada, and the Institute for Plant Protection in Forests in Germany.

Beech bark disease research: Work on the inheritance of disease resistance in American beech has progressed; data analysis on American beech DNA profiles has been scored and analyzed but the predicted relatedness must be contrasted to that from a second analysis after new software is obtained.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4510

Tree Response to Injury and Infection in a Changing Environment

Shortle, Walter C., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Determine magnitude of forest damage attributable to nutrient deficiencies re acid deposition	FPR	202	2.0	1		
2. Develop dependable early markers for detecting changes in vulnerability of forest trees	FPR	212	1.0	2		5

Problem 1 **Determine magnitude of forest damage attributable to nutrient deficiencies re acid deposition**
FY 95 Research Attainments

Publications

Research Unit

Smith, Kevin T. 1995. Tree biology and city life. In: Proceedings of the tree in the city: first Italian international days about trees; 1995 April 4-6; Merano, Italy. Merano, Italy: International Society of Arboriculture: 151-156.

Attainment

We have nearly completed the fourth year of a 4-year study involving a multidisciplinary team of scientists working across a four state area (NY/VT/NH/ME) to understand how changes in soil base cation chemistry are related to changes in atmospheric chemistry during the 20th century. Using dendrochemical techniques developed by this Unit, we have been able to detect a band of tree-ring tissue enriched with Ca and other cations which indicates a shift in the base status of the forest floor (the primary rooting zone in spruce). This band is coincident in time with the deposition of excess sulfate and nitrate in the ice sheets of Greenland, with the acidification of lakes in the Adirondacks of New York, and with the period of greatest increases in emission of sulfur and nitrogen oxides into the atmosphere of the eastern United States. The linkage of emissions to deposition to ion mobilization to increased uptake and nutrient depletion of the forest floor is consistent with models based on Donnan equilibrium theory being developed by the research team for northern forest ecosystems. Several papers have already been submitted for peer review and will soon be published; others are being prepared as the team brings together several years of data. As we develop a better understanding of the forest soil x atmosphere interactions, we need to determine if observed changes are adversely affecting the health and productivity of forest trees. To do this we are developing biologic markers which link the external physical chemistry to the internal biological chemistry, see Problem 2.

Problem 2 **Develop dependable early markers for detecting changes in vulnerability of forest trees**
FY 95 Research Attainments

Publications

Research Unit

Minocha, Rakesh; Kvaalen, Harald; Long, Stephanie; Minocha, Subhash C. 1994. Changes in polyamines and their biosynthetic enzymes during somatic embryogenesis of Picea abies and Picea rubens. In: Pardos, J.A.; Ahuja, M.R.; Rossello, R. Elena, eds. Biotechnology of trees: proceedings of IUFRO working party S2.04-07, somatic cell genetics; 1993 October 18-22; Valsain, Spain. Fuera de Ser. 4. Madrid, Spain: INIA-Instituto Nacional de Investigacion y Technologia Agraria y Alimentaria: 137-142.

Minocha, Rakesh; Shortle, Walter C.; Long, Stephanie L.; Minocha, Subhash C. 1994. A rapid and reliable procedure for extraction of cellular polyamines and inorganic ions from plant tissues. Journal of Plant Growth Regulation. 13: 187-193.

Cooperative

Minocha, Rakesh; Minocha, Subhash C.; Simola, Liisa Kaarina. 1995. Somatic embryogenesis and polyamines in woody plants. In: Jain, S.; Gupta, P.; Newton, R., comps., eds. Somatic embryogenesis in woody plants, vol. 1. Dordrecht, Netherlands: Kluwer Academic Publishers: 337-359.

Minocha, S.C.; Minocha, R. 1995. Role of polyamines in somatic embryogenesis. In: Bajaj, Y.P.S., comp., ed. Somatic embryogenesis and synthetic seed I. Biotechnology in agriculture and forestry, vol. 30. Berlin, Germany: Springer-Verlag: 53-70.

Minocha, Subhash C.; Minocha, Rakesh. 1995. Historical aspects of somatic embryogenesis in woody plants. In: Jain, S.; Gupta, P.; Newton, R., comps., eds. Somatic embryogenesis in woody plants, vol. 1. Dordrecht, Netherlands: Kluwer Academic Publishers: 9-22.

Sun, Dong-yu; Minocha, Rakesh; Minocha, Subhash C. 1994. Genetic transformation of Populus to modulate polyamine metabolism. In: Pardos, J.A.; Ahuja, M.R.; Rossello, R. Elena, eds. Biotechnology of trees: proceedings of IUFRO working party S2.04-07, somatic cell genetics; 1993 October 18-22; Valsain, Spain. Fuera de Ser. 4. Madrid, Spain: INIA-Instituto Nacional de Investigacion y Technologia Agraria y Alimentaria: 215-220.

Zhou, Xinhua; Minocha, Rakesh; Minocha, Subhash C. 1995. Physiological responses of suspension cultures of Catharanthus roseus to aluminim: changes in polyamines and inorganic ions. Journal of Plant Physiology. 145: 277-284.

Attainment

Good progress has been made in our search for useful markers of changes in tree biology associated with adverse external environmental changes. Metal ratios in fine root tips are excellent markers of adverse soil conditions, but sampling is very difficult. Polyamine concentrations in foliage show great promise as indicators of stress induced indirectly by the action of aluminum on the fine root system of mature trees. Aluminum mobilized by acidic deposition has direct effects on root cells which can be modeled with cell suspension cultures. Results of our first major field study involving 6 sites sampled 4 times over a 2-year period indicated that the polyamine, putrescine, accumulates in foliage at sites where aluminum mobilization appears to be strong. As this work is sent out for peer review, we are looking at several antioxidants and their related enzymes as potential comarkers with polyamines. We are again using cell suspension model systems for the initial stage of evaluation before going to the field. Preliminary work looks promising. Simple electrical resistance measurements are also being evaluated as part of a system to detect increasing stress and damage potential in mature trees. Tree-ring patterns are another means of evaluating the status of tree health and productivity. No one marker of internal stress in a biological system is sufficient to detect impending trouble in the forest, but we seek to discover a small set of markers than can potentially help forest managers detect and reduce stress before damage occurs.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4557

Silvicultural Options for the Gypsy Moth
Gottschalk, Kurt W., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Effects of damage by the gypsy moth and its associated organisms in various types of stands	FPR	373	1.0	2	2	
2. Silvicultural practices in reducing damage to forest stands by the gypsy moth	FPR	365	1.0	1	2	1
3. Develop and evaluate decision-making systems to manage the gypsy moth	FPR	720	2.0	5		4
5. Global Change Program	FPR	360	1.0	3		
6. Miscellaneous	FPR	0	.0	2		

Problem 1 **Effects of damage by the gypsy moth and its associated organisms in various types of stands**
FY 95 Research Attainments

Publications

Research Unit

Gottschalk, Kurt W.; Muzika, Rose-Marie. 1995. Ecological and socio-economic effects of gypsy moth on forests. In: Hilburn, D.J.; Johnson, K.J.R.; Mudge, A.D., eds. Proceedings of the 1994 annual gypsy moth review; 1994 October 30-November 2; Portland, OR. [Place of publ. unknown]: National Gypsy Moth Management Board: 116-117.

Muzika, R.M.; Twery, M.J. 1995. Regeneration in defoliated and thinned hardwood stands of north-central West Virginia. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 326-340.

Extramural

Bennett, Deborah J. 1995. Modeling a decision process: hazard and risk assessment for areas threatened by gypsy moth infestation. Morgantown, WV: West Virginia University. 115. M.S. thesis.

Piel, William H. 1995. A new Chrosiothes spider from West Virginia (Araneae, Theridiidae). Journal of Arachnology. 22: 181-184.

Attainment

Studies of gypsy moth defoliation and mortality effects has produced information on successional patterns in the Appalachian Plateau, hazard rating, and fundamental knowledge about arthropod populations in forests susceptible to gypsy moth. Oak dominated stands in West Virginia were found to be replaced by black cherry and red maple to a lesser extent following defoliation. This represents a significantly different finding from areas studied in other parts of the Northeast. In studying effects of gypsy moth on arthropod communities, it is necessary to gather other baseline data describing species composition, diversity and richness. In the course of these studies in West Virginia, a new species of spider was identified. The nearest relative of this spider is from Mexico. Such findings underscore the signficance of gathering pre-disturbance data, and important contributions of all organisms to the biological diversity in forests of the mid-Appalachians.

Problem 2 **Silvicultural practices in reducing damage to forest stands by the gypsy moth**
FY 95 Research Attainments

Publications

Research Unit

Gottschalk, Kurt W.; MacFarlane, W. Russ. 1994. Using silviculture to increase forest health: a national forest/research/state and private demonstration area. In: Foley, Louise H., comp. Silviculture: from the cradle of forestry to ecosystem management: proceedings of the national silviculture workshop; 1993 November 1-4; Hendersonville, NC. Gen. Tech. Rep. SE-88. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 132-136.

Cooperative

Byington, T. Scott; Gottschalk, Kurt W.; McGraw, James B. 1994. Within-population variation in response of red oak seedlings to herbivory by gypsy moth larvae. American Midland Naturalist. 132: 328-339.

Extramural

Grushecky, Shawn Tyler. 1995. Effects of gypsy moth-oriented silvicultural thinnings on small mammal populations and rates of predation on gypsy moth larvae and pupae. Morgantown, WV: West Virginia University. 107. M.S. thesis.

Raneri, Christopher P. 1995. Vulnerability of oak regeneration in Appalachian clearcuts to gypsy moth defoliation. Morgantown, WV: West Virginia University. 74. M.S. thesis.

Attainment

Defoliation increased mortality and reduced growth differentially among nine open-pollinated families of northern red oak seedlings. Family differences in plant size before defoliation explained much of the variation in mortality and growth following defoliation. Intraspecific variation in red oak for tolerance and response to defoliation may result in evolutionary change in natural populations of red oak so that they are more resistant to defoliation in the future. Oak regeneration inside clearcuts is subject to defoliation but it did not contribute significantly to mortality of oak regeneration. Average oak mortality increased with increasing clearcut age. Age class and proportion of oak in a clearcut contributed significantly to predicting oak mortality. A cooperative area was established on the Glenwood Ranger District Jefferson National Forest, to demonstrate the effectiveness of silvicultural treatments in minimizing gypsy moth effects to the public and forest resource professionals and provide additional research data on the effectiveness of the treatments versus direct insect treatments.

Problem 3 **Develop and evaluate decision-making systems to manage the gypsy moth**
FY 95 Research Attainments

Publications

Research Unit

Colbert, J.J.; Racin, George. 1995. User's guide to the Stand-Damage Model (version 1.1) [computer program]. Gen. Tech. Rep. NE-207. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 38.

(1 computer disk (3-1/2 inch); User's manual.)

Colbert, J.J.; Sheehan, Katharine A. 1995. Description of the stand-damage model: part of the gypsy moth life system model. Gen. Tech. Rep. NE-208. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 111.

Liebhold, A.M.; Elkinton, J.S.; Zhou, G.; Hohn, M.E.; Rossi, R.E.; Boettner, C.W. 1995. Regional correlation of gypsy moth (Lepidoptera: Lymantriidae) defoliation with counts of egg masses, pupae, and male moths. Environmental Entomology. 24 (2): 193-203.

Liebhold, Andrew; Thorpe, Kevin; Ghent, John; Lyons, D. Barry. 1994. Gypsy moth egg mass sampling for decision-making: a user's guide. NA-TP-04-94. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area and Southern Region. 12.

Racin, George; Colbert, J.J. 1995. Guide to the Stand-Damage Model interface management system. Gen. Tech. Rep. NE-209. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 149.

Cooperative

Christie, I.; Wilder, J.W.; Colbert, J.J. 1995. Modeling of one-dimensional spatial effects on the spread of gypsy moths. Ecological Modelling. 78: 219-234.

Gribko, Linda S.; Liebhold, Andrew M.; Hohn, Michael E. 1995. Model to predict gypsy moth (Lepidoptera: Lymantriidae) defoliation using kriging and logistic regression. Environmental Entomology. 24 (3): 529-537.

Lyons, D. Barry; Liebhold, Andrew M. 1994. Microclimatic effects on the phenology of egg hatch of the gypsy moth, Lymantria dispar (Lepidoptera: Lymantriidae). In: Logan, Jessie A.; ODell, Thomas M.; Gray, David R., eds. Diapause and gypsy moth management: status, applications, and research; 1991 October 2-3; Blacksburg, VA. Gen. Tech. Rep. NE-193. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 27-40.

Zhou, Guofa; Liehbold, Andrew M. 1995. Forecasting the spatial dynamics of gypsy moth outbreaks using cellular transition models. Landscape Ecology. 10 (3): 177-189.

Attainment

Research progress has occurred in several modeling areas. The Stand Damage Model has been completed. It will predict the mortality and growth of forest stands using defoliation levels supplied by the user. The user-friendly software complete with User's Guide, Documentation, and Interface Guide are bundled together in a package for the user. A previously-developed model using three differential equations was modified to study the spread of gypsy moth populations. The spatio-temporal patterns are globally affected by changes in the search rates of gypsy moth and natural enemies for food and by pesticide applications. Landscape-scale analyses of gypsy moth defoliation using geostatistical techniques produced several models for predicting gypsy moth defoliation given spatio-temporal data of past defoliation. Regional defoliation patterns have also been correlated with regional patterns of gypsy moth egg masses, pupae, and male moths. Guidelines and techniques for sampling gypsy moth egg masses to make management decisions have been summarized in a user's guide. The user's guide provides sampling procedures for fixed radius plots, prediction of defoliation from measurements, and thresholds for management decisions. Variations in gypsy moth egg hatch occur that are linked to variations in microhabitat distribution and substrate temperature. Understanding the microclimatic variables that influence hatch time will improve the accuracy of egg-hatch predictions.

Problem 5 **Global Change Program**
FY 95 Research Attainments

Publications

Research Unit

Williams, David W.; Liebhold, Andrew M. 1995. Detection of delayed density dependence: effects of autocorrelation in an exogenous factor. Ecology. 76 (3): 1005-1008.

Williams, David W.; Liebhold, Andrew M. 1995. Forest defoliators and climatic change: potential changes in spatial distribution of outbreaks of western spruce budworm (Lepidoptera: Tortricidae) and gypsy moth (Lepidoptera: Lymantriidae). Environmental Entomology. 24 (1): 1-9.

Williams, David W.; Liebhold, Andrew M. 1995. Potential changes in spatial distribution of outbreaks of forest defoliation under climate change. In: Harrington, R.; Stork, N.E., comps., eds. Insects in a changing environment. London, UK: Academic Press: 509-513.

Attainment

The potential effect of global climate change on forest defoliator outbreaks was evaluated using a statistical model in a geographical information system (GIS). Historical maps of defoliation caused by the western spruce budworm, Choristoneura occidentalis, in Oregon and gypsy moth, Lymantria dispar, in Pennsylvania were used to fit multivariate models that predict defoliation incidence as a function of climatic variables. Output of several global circulation models to predict the spatial distribution of defoliation under various climatic change scenarios.

Temporal autocorrelation in an exogenouse mortality agent was shown to produce changes in population densities that are diagnostic of delayed density using previously developed analytical techniques. These results indicated that effects of certain natural enemies (e.g. generalist predators) or abiotic agents (e.g. weather) may cause researchers to incorrectly conclude that populations are being driven by a coupled natural enemy populations (e.g. parasitoids).

Problem 6 **Miscellaneous**
FY 95 Research Attainments

Publications

Research Unit

Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. 1995. Proceedings, 10th central hardwood forest conference. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 577.

Liebhold, Andrew M.; MacDonald, William L.; Bergdahl, Dale; Mastro, Victor C. 1995. Invasion by exotic forest pests: a threat to forest ecosystems. Forest Science Monograph. 30: 1-49.

Attainment

A major review of invasion of exotic forest pests was conducted. These forest ecosystems are substantially disturbed and suffer severe socioeconomic impacts. The invasion process includes arrival, establishment, and spread and management can focus on preventing all three phases. Biological invasions are probably the most significant environmental threat to the maintenance of natural forest ecosystems in North America and elsewhere. The proceedings of the 10th Central Hardwood Forest Conference presents 59 papers and 22 abstracts on the ecology, silviculture, hydrology, management, protection, physiology, genetics, regeneration, harvesting, economics, and markets of these unique forests.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4558

Impact of Atmospheric Deposition and Global Change on Forest Health and Productivity

Long, Robert P., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Effect of atmos. dep. stress/change in global climate on tree growth and other variables	FPR	402	4.0	7		3
2. Deter. effects of atmos. dep. on mature trees and how effects differ from those found in seedlings	FPR	396	1.0	3		1

Problem 1 **Effect of atmos. dep. stress/change in global climate on tree growth and other variables**
FY 95 Research Attainments

Publications

Research Unit

Barger, J.H.; Cannon, W.N., Jr.; Hall, R.W. 1995. Host plant and insect herbivore interactions under next century atmospheres. Ohio Journal of Science. 95(2): A-37. Abstract.

Cannon, W.N., Jr.; Barger, J.H.; Hall, R.W. 1995. Effects of long-term CO2 enrichment of white oak on gypsy moth pupal weight. Ohio Journal of Science. 95(2): A-47. Poster.

Cannon, William N., Jr.; Roberts, Bruce R. 1995. Stomatal resistance and the ratio of intercellular to ambient carbon dioxide in container-grown yellow-poplar seedlings exposed to chronic ozone fumigation and water stress. Environmental and Experimental Botany. 35 (2): 161-165.

Long, Robert P.; Horsley, Stephen B.; Lilja, Paul R. 1995. Impact of forest liming on growth and vigor of Allegheny hardwoods. In: Proceedings, sugar maple decline workshop; 1995 June 5-9; Warren, PA. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station and Northeastern Area, State and Private Forestry: 64-74.

McQuattie, Carolyn J.; Schier, George A. 1995. Differences in ultrastructure and aluminum localization in mycorrhizal and nonmycorrhizal pitch pine roots exposed to aluminum. Ohio Journal of Science. 95(2): A-19. Abstract.

Schier, George A.; McQuattie, Carolyn J. 1995. Effect of aluminum on the growth, anatomy, and nutrient content of ectomycorrhizal and nonmycorrhizal eastern white pine seedlings. Canadian Journal of Forest Research. 25: 1252-1262.

Schier, George A.; Patton, Roy L. 1995. Damping-off disease of pine seedlings on soils treated with simulated acidic rain. Canadian Journal of Forest Research. 25: 838-844.

Cooperative

Boerner, Ralph E.J.; Rebbeck, Joanne. 1995. Decomposition and nitrogen release from leaves of three hardwood species grown under elevated 03 and/or CO2. In: Collins, H.P.; Robertson, G.P.; Klug, M.J., comps., eds. The significance and regulation of soil biodiversity. Dordrecht, The Netherlands: Kluwer Academic Publishers: 169-177.

McClenahen, J.R.; Long, R.P. 1995. Variability in oak forest herb layer communities. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 60-78.

Stephenson, Steven L.; Studlar, Susan Moyle; McQuattie, Carolyn J.; Edwards, Pamela J. 1995. Effects of acidification on bryophyte communities in West Virginia mountain streams. Journal of Environmental Quality. 24 (1): 116-125.

Attainment

A wide range of abiotic stresses can affect tree seedling growth, anatomy, or physiology. Pitch pine seedlings inoculated with the mycorrhizal fungus Pisolithus tinctorius or sterile broth, and grown in a low nutrient medium with 0, 10, or 20 mg/L aluminum were evaluated. Aluminum was detected with x-ray analysis (EDS) in outer root cells of nonmycorrhizal (NM) roots, and in dead root cells between mantle hyphae in mycorrhizal (M) roots. NM roots exposed to 20 mg/L Al had disrupted root meristem cells compared with M roots exposed to the same Al concentration. The 20 mg/L Al concentration reduced the thickness of the fungal mantle to an average of 4 hyphae compared to 8 in roots exposed to 0 or 10 mg/L A1. Decomposition studies on nitrogen release from leaves of three hardwood species grown under elevated ozone (03) and/or carbon dioxide (C02) revealed both mass loss and N release were significantly reduced for yellow-poplar leaves grown in elevated C02. This suggests some forests exposed to elevated C02 will have significantly reduced N turnover rates. A 3-year study to evaluate the effects of elevated C02 and 03 on tree growth, nutrient status, and host insect feeding and fecundity was completed. Twice ambient C02 (2X=650 ppm) reduced leaf nitrogen and water content of American elm and white oak. For elm leaf beetle (ELB), herbivory and fecundity were significantly lower on foliage from 2X C02 and 2X C02+2X 03 trees. Gypsy moth larval feeding and pupal weights were unaffected.

Problem 2 **Deter. effects of atmos. dep. on mature trees and how effects differ from those found in seedlings**
FY 95 Research Attainments

Publications

Research Unit

Long, R.P.; Scherzer, A.J. 1995. Sugar maple ecophysiology in relation to genotypic, site and age factors. Ohio Journal of Science. 95(2): A-34. Abstract.

Rebbeck, Joanne; Loats, Ken V.; Scherzef [Scherzer], Amy J. 1995. Second year effects of ozone and elevated carbon dioxide on the physiological response of white pine and yellow-poplar. Ohio Journal of Science. 95(2): A-34-A-35. Abstract.

Scherzer, Amy J.; Rebbeck, Joanne. 1995. Effects of two years of exposure to ozone and elevated carbon dioxide on foliar N and P dynamics of yellow-poplar. Ohio Journal of Science. 95(2): A-35. Abstract.

Cooperative

Carter, Gregory A.; Rebbeck, Joanne; Percy, Kevin E. 1995. Leaf optical properties in Liriodendron tulipifera and Pinus strobus as influenced by increased atmospheric ozone and carbon dioxide. Canadian Journal of Forest Research. 25: 407-412.

Attainment

The long-term response of yellow-poplar and eastern white pine to elevated carbon dioxide (CO2) and ozone (O3) has been studied in open-top chambers since 1992. Large chambers (4.6m diameter, 9m tall) were installed for yellow-poplar treatments in 1995. The treatments include: charcoal-filtered air (CF), 1X ambient O3 (1X), 2X ambient O3 (2X), 2X ambient O3 plus 350 ppm CO2 above ambient (2X+CO2), and open-air (OA) chamberless plot. Biomass and growth stimulations were observed for yellow-poplar in 1993, with mean increases of 14% in stem diameter and 16% in total plant height of yellow-poplar grown in 2X+CO2 compared with all other treatments. No significant effects on growth of white pine were observed. In a related study of yellow-poplar foliar nutrient dynamics, 2X+CO2 treatment decreased nitrogen by 32-38% compared with other treatments; however, foliar P concentrations were unaffected. Leaf optical properties of both yellow-poplar and white pine were studied to determine whether they are sensitive indicators of plant growth conditions. The 2X treatment increased leaf reflectance and transmittance, and decreased leaf absorbance in yellow-poplar. Increasing CO2 (2X+CO2 treatment) ameliorated this effect. In white pine the results were opposite of those in yellow-poplar, demonstrating the genetic component of plant responses to O3.

Northeastern Forest Experiment Station
Forest Products and Harvesting Research
Research Work Unit 4701

Improved Processing Technology for Hardwoods
Wiedenbeck, Janice K., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Need to develop techniques to evaluate production /economic implications using new technologies	FPHR	1003	4.0	20		4
2. Standards and test criteria needed for evaluating CNC machinery and tooling	FPHR	0	.0	1		
3. Techniques needed to make existing information available to decision makers	FPHR	111	.0	2		

Problem 1 **Need to develop techniques to evaluate production /economic implications using new technologies**
FY 95 Research Attainments

Publications

Research Unit

Anderson, R. Bruce. 1995. Quality control in furniture product costing: an activity-based costing approach. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 31. Abstract.

Gatchell, Charles J.; Wiedenbeck, Janice K. 1995. Which end is up? The better and worse ends of red oak lumber. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 66. Abstract.

Gatchell, Charles J.; Wiedenbeck, Janice K.; Walker, Elizabeth S. 1995. Understanding that red oak lumber has a better and worse end. Forest Products Journal. 45 (4): 54-60.

Gregg, Nancy, ed. 1995. Study finds graders useful. In: Vision moves from trimmer to secondary manufacturing. Southern Lumberman. September: 45-47.

Hoff, Kris. 1995. Using designed experimentation in forest products yield research. In: Statistical process control technologies: state of the art for the forest products industry; 1994 November 7-9; Portland, OR. Madison, WI: Forest Products Society. Abstract.

Hoff, Kristen G. 1995. What is production information management? In: Meyer, Dan A., ed. Advances in hardwood utilization: following profitability from the woods through rough dimension: proceedings, 23rd annual symposium of the Hardwood Research Council; 1995 May 17-20; Cashiers, NC. Memphis, TN: Hardwood Research Council: 45-51.

(Work done through a formal cooperative agreement with West Virginia University.)

Klinkhachorn, Powsiri; Gatchell, Charles J.; Moody, John. 1995. UGRS-95: the Ultimate Grading and Remanufacturing System. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 67. Abstract.

Thomas R. Edward. 1995. ROMI-RIP: ROugh MIll RIP-first simulator. Gen. Tech. Rep. NE-206. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 28.

Thomas, R. Edward. 1995. Dynamic cutting bill part prioritizing: a new method. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 66. Abstract.

Thomas, R. Edward; Gatchell, Charles J.; Wiedenbeck, Janice K. 1995. Software for lumber processing decision makers. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 29. Abstract.

Thomas, R. Edward. 1995. ROMI-RIP: ROugh MIll RIP-first simulator user's guide. Gen. Tech. Rep. NE-202. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 72.

Thomas, R. Edward; Gatchell, Charles J.; Walker, Elizabeth S. 1994. User's guide to AGARIS: Advanced GAng RIp Simulator. Gen. Tech. Rep. NE-192. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 54.

Thomas, R. Edward; Wiedenbeck, Jan K.; Gatchell, Charles J. 1995. New decision tools for rough mill dimension processing. In: Meyer, Dan A., ed. Advances in hardwood utilization: following profitability from the woods through rough dimension: proceedings, 23rd annual symposium of the Hardwood Research Council; 1995 May 17-20; Cashiers, NC. Memphis, TN: Hardwood Research Council: 69-75.

Wiedenbeck, Jan; Buhlmann, Urs. 1995. Character-marked furniture: the yield picture. In: Meyer, Dan A., ed. Advances in hardwood utilization: following profitability from the woods through rough dimension: proceedings, 23rd annual symposium of the Hardwood Research Council; 1995 May 17-20; Cashiers, NC. Memphis, TN: Hardwood Research Council: 85-90.

Wiedenbeck, Jan; Thomas, Ed. 1995. Don't gamble your fortunes-focus on rough mill yield. Wood & Wood Products. 100 (7): 148-149.

Wiedenbeck, Janice K.; Buehlmann [Buhlmann], Urs. 1995. Increased yield through expanded use of character marks in furniture production. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 31. Abstract.

Wiedenbeck, Janice K.; Gatchell, Charles J.; Thomas, R. Edward. 1995. FSL rough mill yield improvement team. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 29. Abstract.

Wiedenbeck, Janice K.; Araman, Philip A. 1995. Rough mill simulations reveal that productivity when processing short lumber can be high. Forest Products Journal. 45 (1): 40-46.

Wiedenbeck, Janice K.; Gatchell, Charles J.; Walker, Elizabeth S. 1994. Data bank for short-length red oak lumber. Res. Pap. NE-695. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 16.

Wiedenbeck, Janice K.; Gatchell, Charles J.; Walker, Elizabeth S. 1995. Quality characteristics of Appalachian red oak lumber. Forest Products Journal. 45 (3): 45-50.

Cooperative

Anderson, James D.; Thomas, R. Edward; Brunner, Charles C.; Gatchell, Charles J. 1995. CORY version USDA-1 crosscut-first simulator user's guide. Gen. Tech. Rep. NE-196. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 17.

(Work done through a formal cooperative agreement with Oregon State University.)

Lin, Wenjie; Kline, D. Earl; Araman, Philip A.; Wiedenbeck, Janice K. 1995. Design and evaluation of log-to-dimension manufacturing systems using system simulation. Forest Products Journal. 45 (3): 37-44.

(Work conducted in cooperation with Virginia Polytechnic Institute and State University.)

Lin, Wenjie; Kline, D. Earl; Araman, Philip A.; Wiedenbeck, Janice K. 1995. Producing hardwood dimension parts directly from logs: an economic feasibility study. Forest Products Journal. 45 (6): 38-46.

(Work conducted in cooperation with Virginia Polytechnic Institute and State University.)

Patterson, David W.; Anderson, R. Bruce. 1995. Use of statistical process control in the cabinet and furniture industries. In: Statistical process control technologies: state of the art for the forest products industry: proceedings from the statistical process control conference; 1994 November 7-9; Portland, OR. Madison, WI: Forest Products Society: 86-88.

(Work done through a formal cooperative agreement with West Virginia University.)

Attainment

During FY-95, we produced a significant modeling/decision-support tool, ROMI-RIP, a rough mill gang-rip-first simulator. This program takes rough mill yield simulation to a significantly higher level both in terms of useability and realism. It serves as a modeling tool for our scientists enhancing our ability to make critical assessments of the yield effects associated with many secondary processing automation options. It is being used in three ongoing research studies. Our yield simulators also serve as decision-support tools for secondary wood processors. We have filled more than 150 requests for ROMI-RIP in its first 2 months of publication. The red oak lumber data base that is integral to the yield simulation programs is being expanded and updated as are the computer-based grading programs (REGS and UGRS with WVU). NE-4701 provided significant technical advice and performed numerous validation checks to bring about this program advance. In response to needs expressed by a major secondary processing industry association, we are establishing rough mill yield and efficiency benchmarks. A second study exploring furniture part yield improvement opportunities associated with lumber remanufacturing and sorting strategies was completed. We initiated a study on the wood resource impact of broader acceptance of character (defects) in furniture (with VPI&SU). Our statistical process control (SPC) research program includes a study, nearing completion, that looks at implementation opportunities for SPC in secondary wood machining operations (with WVU). The current emphasis is on automated quality detection and control mechanisms for CNC machines. NE-4701 is nearing completion of a research study that ties into the national wood utilization in ecosystem management program–we are benchmarking quality/size of the lumber resource being processed by secondary manufacturers in Appalachian region.

Problem 2 **Standards and test criteria needed for evaluating CNC machinery and tooling**
FY 95 Research Attainments

Publications

Research Unit

Adams, Edward L.; Rast, Everette D.; Bennett, Neal D. 1995. CNC router evaluation procedures. Gen. Tech. Rep. NE-201. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 138.

Attainment

During the course of this multi-year research program, exhaustive tests have been run on computer numerically controlled (CNC) routers. CNC router evaluation procedures have been established that provide companies with a system for comparing available machinery so that they can make informed investment decisions. A major summary publication that contains our proposed CNC router evaluation procedures was completed. A concurrent study conducted with North Carolina State University designed to produce a spindle vibration evaluation and rating system for CNC routers also was completed. Work on this problem is drawing to a close; we are in the fifth year of a 5-year program. The primary scientist working in this area retired from the Forest Service in January 1995.

Problem 3 **Techniques needed to make existing information available to decision makers**
FY 95 Research Attainments

Publications

Research Unit

Gatchell, Charles J.; Thomas, R. Edward. 1995. A preview of secondary wood processing simulation. NE-INF-124-95. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 4.

Wiedenbeck, Janice K.; West, Cynthia D.; Sonderman, David L. 1995. Hardwood processing, product, and market research at the Forestry Sciences Laboratory, Princeton, West Virginia. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society: 66. Abstract.

Attainment

Work under this problem has produced a wood products processing information system that is heavily used by industrial, individual, and research customers. Databases covering many aspects of secondary wood processing provide ready answers to a wide-range of questions; over 4,000 information requests have been answered since 1988 and more than 600 were answered during 1995. This year, the information compilation and dissemination effort focused on the delivery of information on process control and processing simulation software programs designed to help industry optimize their processing systems. This emphasis supports our research and development efforts under Problem 1. During 1995, 42% of our information requests pertained to rough mill processing and yield.

Northeastern Forest Experiment Station
Forest Products and Harvesting Research
Research Work Unit 4751

Systems to Integrate Harvesting With Other Resource Management Objectives

LeDoux, Chris, Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Inadequate forest management planning tools for steep terrain	FPHR	150	.5	4		1
2. Inadequate methods to plan/carry out multiproduct harvest/util. of E. hardwood on steep terrain	FPHR	150	.5	2		

Problem 1 **Inadequate forest management planning tools for steep terrain**
FY 95 Research Attainments

Publications

Research Unit

Baumgras, John E.; LeDoux, Chris B. 1995. Hardwood silviculture and skyline yarding on steep slopes: economic and environmental impacts. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-7; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 463-473.

LeDoux, Chris B.; Gopalakrishnan, B.; Lankalapalli, K. 1995. FOREX–an expert system for managing even-aged upland oak forests on steep terrain. In: Gottschalk, Kurt W.; Fosbroke, Sandra, L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-7; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 474-480.

LeDoux, Chris B.; May, Dennis M.; Johnson, Tony; Widmann, Richard H. 1995. Assessing the feasibility and profitability of cable logging in southern upland hardwood forests. Southern Journal of Applied Forestry. 19 (3): 1-6.

Sloan, Hank; LeDoux, Chris B.; McWilliams, William H.; Worthington, Virginia E. 1995. Sustainability of forest products production in the Jefferson National Forest market area. In: Hassan, Awaitf E.; Sherar, Jim; Swanner, Jack, eds. Sustainability, forest health & meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 100-120.

Cooperative

Huyler, Neil K.; LeDoux, Chris B. 1995. Estimating the cost of applying Vermont acceptable management practices to logging on moderate slopes. In: Hassan, Awaitf E.; Sherar, Jim; Swanner, Jack, eds. Sustainability, forest health & meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 165-171.

Attainment

Stump-to-mill logging cost estimating methodologies were integrated with FIA inventory data to determine the sustainability of forest products production in the Jefferson National Forest market area. Emphasis was placed on the economic availability of timber supplies when the resource is segregated into three quality categories - high, medium, and low. Initial results suggest that the high-quality segment is incurring the greatest pressure. An expert system, FOREX, was developed for cable and ground-based logging of oak-hickory forests. The expert system provides information on present net worth, optimal entry timing, optimal stand rotation age, diameter at breast height, volume by grade, and volume of the trees harvested, and based on the logging technology used, the average slope yarding distance, truck class, road class, log-bucking methods, and the number of thinnings desired. Environmental impacts associated with cable logging shelterwood and thinnings were also reported. Results of this research has been presented to other researchers, loggers, policy makers, and resource managers through publications, symposia, and other technology transfer outlets.

Problem 2 **Inadequate methods to plan/carry out multiproduct harvest/util. of E. hardwood on steep terrain**
FY 95 Research Attainments

Publications

Research Unit

Baumgras, John E.; Miller, Gary W.; LeDoux, Chris B. 1995. Economics of hardwood silviculture using skyline and conventional logging. In: Meyer, Dan A., ed. Advances in hardwood utilization: following profitability from the woods through rough dimension: proceedings, 23rd annual symposium of the Hardwood Research Council; 1995 May 17-20; Cashiers, NC. Memphis, TN: Hardwood Research Council:

Baumgras, John E.; Sherar, James R.; LeDoux, Chris B. 1995. Environmental impacts from skyline yarding partial cuts in an Appalachian hardwood stand: a case study. In: Hassan, Awaitf E.; Sherar, Jim; Swanner, Jack, eds. Sustainability, forest health & meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 87-96.

Attainment

A case study was conducted to evaluate the environmental impacts of skyline yarding hardwood thinnings and shelterwood cuts. Results reported include: frequency and severity of residual stand damage, harvested area with specific levels of soil disturbance, and relationships between skyline deflection and soil disturbance. Most of the soil disturbance sampled was located in the sections of the skyline corridor where deflection was limited. Levels of residual stand damage for each treatment were comparable to previous results from other studies. Visual quality was evaluated by the use of oblique aerial photos taken before and after the harvests. Results from the visual quality assessment suggest that the use of thinnings and shelterwood cuts improves visual quality over clearcut methods. Timber harvesting simulations of alternative silvicultural and cable and ground-based logging technologies suggest that harvesting technology had less impact on harvesting revenue than silvicultural method or roundwood prices. Hardwood markets and prices have the most impact on cash flows.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4801

Forest Inventory and Analysis
Peters, John R., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Conduct periodic forest resources inventories and evaluations	RAR	1975	.5	5		2
2. Conducting special analyses of specific resource issues and concerns	RAR	788	1.5	7		4

Problem 1 **Conduct periodic forest resources inventories and evaluations**
FY 95 Research Attainments

Publications

Research Unit

Hershey, Rachel Riemann; Befort, William A. 1995. Aerial photo guide to New England forest cover types. Gen. Tech. Rep. NE-195. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 70.

McWilliams, William A.; Arner, Stanford L.; Frieswyk, Thomas S.; Hershey, Rachel Riemann; Wharton, Eric H. 1995. Ecoregion-scale forest monitoring and assessment: Pennsylvania case study. In: EMAP symposium: monitoring, assessment & science policy: platform abstracts; Chapel Hill, NC. [Place of publication unknown]: [Publisher name unknown]: 33. Abstract.

Wharton, Eric H. 1995. The timber industries of Pennsylvania, 1988. Resour. Bull. NE-130. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 40.

Widmann, Richard H. 1995. Forest resources of Pennsylvania. Resour. Bull. NE-131. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 41.

Widmann, Richard H. 1995. The Empire State's forest–trends in a robust resource. NE-INF-126-95. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 4.

Cooperative

Hahn, J.T.; MacLean, C.D.; Arner, S.L.; Bechtold, W.A. 1995. Procedures to handle inventory cluster plots that straddle two or more conditions. In: Techniques for forest surveys when cluster plots straddle two or more conditions. Forest Science Monograph. 31: 12-25.

Schmidt, Tom; Connor, Roger; McWilliams, Will; O'Brien, Renee; Ohmann, Janet; Powell, Doug. 1995. An ecological approach for inventorying, classifying and monitoring our nation's forests. In: Managing forests to meet peoples' needs: proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 September 18-22; Anchorage, AK. SAF Publ. 95-02. Bethesda, MD: Society of American Foresters: 463-464.

Attainment

Analysis of Pennsylvania's forests progressed as reports covering forest resources and timber industries in the State were published. The report on forest resources found general improvement of conditions as the area of forest land remained stable, inventory volume continued to increase, average tree size increased, and growth continued to exceed removals–by a factor of two to one. The timber industries publication reported that Pennsylvania has become the first state in the Northeast to exceed one billion board feet of product output. More than two-thirds of the State's harvest was in the form of sawlogs. An inventory of New York's forests was completed and a brief overview of conditions was published in a popularized color format. In general, resource conditions in New York are favorable. Forest area increased and significant gains in inventory volume were recorded. Further analysis is planned for FY-96. Field work for the ongoing inventory of Maine's forests continues and will be completed in the Fall of 1995. Compilation of the data and publication of the results is expected in FY-96. An aerial photo guide for New England forest types was published. The photo guide provides new keys that enable photo interpreters to identify forest cover types common in New England from aerial photos and relate the information to ecological conditions and the natural ranges of the region's forest types.

Problem 2 **Conducting special analyses of specific resource issues and concerns**
FY 95 Research Attainments

Publications

Research Unit

Gansner, David A. 1995. Shifts in stocking reveal forest health problems. NA-TP-07-95. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, State and Private Forestry. 9.

(Although published by NA; David A. Gansner was the author.)

Gansner, David A. 1995. Using forest survey data to map the defoliation potential of gypsy moth. In: Kohl, Michael; Bochman, Peter; Brassel, Peter; Preto, Giovannie, eds. The Monte Verita conference on forest survey designs: simplicity versus efficiency an assessment of non-timber resources; 1994 May 2-7; Ascona, Switzerland. Zurich/Birmensdorf, Switzerland: Swiss Federal Institute for Forest, Snow and Landscape Research and Swiss Federal Institute of Technology: 290-295.

Gansner, David A.; King, Susan L.; Arner, Stanford L.; Widmann, Richard H.; Drake, David A. 1995. Spatial trends in relative stocking point to potential problems in forest health. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 401-420.

Gansner, David A.; King, Susan L.; Widmann, Richard H. 1995. Shifts in relative stocking point to potential problems in forest health. In: Managing forests to meet peoples' needs: proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 September 18-22; Anchorage, AK. SAF Publ. 95-02. Bethesda, MD: Society of American Foresters: 465-466.

Gansner, David A.; Quimby, John W.; King, Susan L.; Arner, Stanford L.; Drake, David A. 1995. Tracking changes in the susceptibility of forest land infested with gypsy moth. Gypsy Moth News. 37: 3-6.

McWilliams, William H.; Bowersox, Todd W.; Gansner, David A.; McCormick, Larry H.; Stout, Susan L. 1995. Landscape-level regeneration adequacy for native hardwood forests of Pennsylvania. In: Gottschalk, Kurt W.; Fosbroke, Sandra, L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 196-203.

Widmann, Richard H.; Gansner, David A. 1994. Has the gypsy moth destroyed Pennsylvania's oak resource? In: Kuharic, Kathryn, comp. Proceedings of the 1993 annual gypsy moth review; 1993 November 1-4; Harrisburg, PA. [Place of publ. unknown]: National Gypsy Moth Management Board: 200-207.

Cooperative

LeDoux, Chris B.; May, Dennis M.; Johnson, Tony; Widmann, Richard H. 1995. Assessing the feasibility and profitability of cable logging in southern upland hardwood forests. Southern Journal of Applied Forestry. 19 (3): 97-102.

Leak, William B.; Cullen, J.B.; Frieswyk, Thomas S. 1995. Dynamics of white pine in New England. Res. Pap. NE-699. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 8.

Powell, Douglas S.; McWilliams, William H.; Birdsey, Richard A. 1994. History, change and the U.S. forest inventory. Journal of Forestry. 92 (12): 6-11.

Sloan, Hank; LeDoux, Chris B.; McWilliams, William H.; Worthington, Virginia E. 1995. Sustainability of forest production in the Jefferson National Forest market area. In: Council on forest engineering; sustainability, forest health & meeting the nation's needs for wood products; 1995 June 5-8; Cashiers, NC. [Place of publ. unknown]: [Publisher name unknown]: 100-120.

Attainment

Models of gypsy moth defoliation were used in conjunction with recent inventory data to track defoliation potential along the frontier of its spread. Maps and analyses were published to highlight the spatial location of pathways with highly susceptible forest acreage. A complimentary analysis of the long-term impact of gypsy moth on oak forests of Pennsylvania was also published. A comprehensive set of relative density equations was applied to forest inventory data to assess changes in the stocking of tree species in portions of the Northeast. Maps showing changes in stocking indicate potential forest health concerns for the major species of the region. Results of two regeneration surveys in Pennsylvania yielded some alarming results relating to the regenerative capacity of the State's forests. A study of advance regeneration showed that only 6 percent of the sample plots were adequately stocked with commercial tree species. A study of oak regeneration following disturbance found that the stocking of oak species was far below what it was prior to disturbance. A nationwide study of private forest landowners was completed. The study estimates the number of private landowners in each State and describes the owners in terms of occupation, size of holding, harvest intention, and other characteristics. Preliminary results of the study were presented at a number of national conferences. Full publication of the results is expected in FY-96.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4803

Analysis of Domestic and International Hardwood Product Markets
West, Cynthia D., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Explain the interrelationships among domestic markets for hardwood products	RAR	343	1.5	5		3
2. Develop more detailed information on int'l. hardwood products trade and describe impact	RAR	300	1.0	5		3
3. Market-based decision making tools which can be used by hardwood processors and rural land owners	RAR	214	.5	1		1

Problem 1 **Explain the interrelationships among domestic markets for hardwood products**
FY 95 Research Attainments

Publications

Research Unit

Engle, Catherine A.; Bush, Robert J.; West, Cynthia D. 1995. The use of substitute material pallets by the grocery distribution industry. In: Research update from the Center for Forest Products Marketing. Blacksburg, VA: Virginia Polytechnic Institute and State University: 4.

Engle, Catherine A.; West, Cynthia D.; Bush, Robert J. 1994. The use of substitute material pallets by the grocery distribution industry. Pallet Enterprise. 14 (10): 24-26.

Hansen, Bruce G. 1995. The relationship between quality and the selection and purchase of office furniture. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society. 55. Abstract.

Nolley, Jean. 1995. Bulletin of hardwood market statistics: fall 1994. Res. Note NE-357. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 23.

Scheerer, Catherine E.; Bush, Robert J.; West, Cynthia D. 1995. The use of substitute material pallets by the grocery distribution industry. In: Forest Products Society 49th annual meeting: abstracts; 1995 June 25-28; Portland, OR. Madison, WI: Forest Products Society. 32. Abstract.

Cooperative

Bush, Robert; Hansen, Eric; Punches, John. 1994. Wood use in the U.S. pallet and container industry: 1993. Virginia Polytechnic and State University. Blacksburg, VA: Virginia Polytechnic and State University. 20.

(Work performed under cooperative agreement with Virginia Polytechnic and State University.)

Hansen, Eric; Bush, Robert; Punches, John. 1993. Wood materials use in the U.S. furniture industry: 1992-1994. Blacksburg, VA: Virginia Polytechnic Institute and State University. 33.

(Work performed under cooperative agreement with Virginia Polytechnic Institute and State University.)

McCurdy, Dwight R.; Phelps, John E. 1995. Characteristics of pallet use in the United States, 1993. Carbondale, IL: Southern Illinois University. 12.

(Work performed under cooperative agreement with Southern Illinois University.)

Attainment

Hardwood lumber production in the United States is between 11 and 12 billion board feet annually. An ongoing study assessing hardwood lumber use by major industry segments revealed that over half is consumed by the pallet and furniture industries. Red oak is the most important species utilized by the furniture industry, 35% of lumber purchases. While No. 1 common is the most important grade used (54%), 34% of lumber purchases were No. 2 common or lower. The industry is predicted to increase use of composite and panel products at a faster rate than hardwood lumber and dimension. The pallet industry is the most important demand segment for hardwood lumber utilizing between 42 and 45% of lumber production; estimated use is predicted to increase almost 14% in 1995 over 1993. Two indepth studies of pallet use provide insight into future pallet demand and material requirements. There are a variety of uses for pallets. These uses dictate design and material use. Double-faced flush stringer pallets were preferred in all applications; solid wood pallets were also the most preferred. However, there is a growing trend towards use of alternative material pallets in at least one important industry segment–grocery distributors. One study revealed plastic pallets to be used by an estimated 22% of grocery distributors in 1994 and users were estimated to increase by 70% by 1997. Plastic pallets were rated higher than wood on the major factors: quality, durability, cost per use, and handling safety. These emerging trends could potentially have tremendous impacts on low grade hardwood use. Therefore, it is imperative that we continue to monitor and assess wood use by major demand segments.

Problem 2 **Develop more detailed information on int'l. hardwood products trade and describe impact**
FY 95 Research Attainments

Publications

Research Unit

Hansen, Bruce G. 1995. Estimating the tropical/temperate mix of European hardwood lumber exports. Forest Products Journal. 45 (1): 37-39.

Luppold, William G. 1995. Causes and remedies for errors in international forest products trade data: examples from the hardwood trade statistics. Forest Science. 41 (2): 278-283.

West, Cynthia D. 1995. Imported furniture and market trends in the United States. In: Enhancing Malaysia's competitive edge in furniture marketing. Kuala Lumpur, Malaysia: Malaysian Timber Industry Board and Malaysian Furniture Industry Council: 7.

West, Cynthia D.; Cooper, Juett R. 1995. Relationships between marketing and technology policies: an empirical study. In: Moore, Dorothy Perrin, ed. Proceedings, 55th annual meeting of the Academy of Management; 1995 August 6-9; Vancouver, BC. Charleston, SC: Academy of Management: 599.

West, Cynthia D.; Smith, Paul M. 1995. The Asia-Pacific Basin: opportunities for cooperation in furniture production and marketing. In: Enhancing Malaysia's competitive edge in furniture marketing. Kuala Lumpur, Malaysia: Malaysian Timber Industry Board and Malaysian Furniture Industry Council: 9.

Cooperative

McCurdy, Dwight R.; Phelps, John E. 1995. Characteristics of pallet use in the U.S., 1993. Timber Producer. May: 22-30.

(Work performed under cooperative agreement with Southern Illinois University.)

McCurdy, Dwight R.; Phelps, John E. 1995. Pallet users. Timber Processing. June; 20: 32-38.

(Work performed under cooperative agreement with Southern Illinois University.)

Smith, Paul M.; Haas, Michael P.; Luppold, William G. 1995. An analysis of tropical hardwood product importation and consumption in the United States. Forest Products Journal. 45 (4): 31-37.

(Work performed under cooperative agreement with Pennsylvania State University.)

Attainment

In 1994, the United States exported nearly 1.3 billion board feet of hardwood logs and lumber. The Hardwood Manufacturers Association cited the export market as the most important new development for the industry in the past decade. Many business decision makers and government policy makers depend on current and detailed trade information. Assessing U.S. hardwood trade requires analysis and comparison of several sources of trade data due to lack of reliability of any single source. The United States is the single largest supplier of temperate hardwoods. It is believed that increasing concern over tropical deforestation could have a significant impact on future demands for U.S. hardwoods. An analysis of European imports of tropical species over the last two decades revealed a general decline. However market share of tropical species varies between individual countries - tropical species account for 25% of Italian hardwood imports to 70% of Netherland imports. In contrast, the wood using industry in the United States, uses very little tropical materials. An assessment of tropical wood use by the U.S. furniture industry revealed that only 4% of the tropical timber traded that year was consumed by U.S. producers. Exports of value added products would provide increasing rewards and opportunities for U.S. producers. Recent analysis of Japanese trade statistics reveals a 600% increase in wood furniture parts imports over the last 10 years; and, a growing furniture industry in the ASEAN region, due in part to Japanese investment.

Problem 3 — Market-based decision making tools which can be used by hardwood processors and rural land owners
FY 95 Research Attainments

Publications

Research Unit

Sloan, Hank; LeDoux, Chris B.; McWilliams, William H.; Worthington, Virginia E. 1995. Sustainability of forest products production in the Jefferson National Forest market area. In: Hassan, Awatif E.; Sherar, Jim, Swanner, Jack, eds. Sustainability, forest health & meeting the nation's needs for wood products: proceedings of the Council on Forest Engineering 18th annual meeting; 1995 June 5-8; Cashiers, NC. Raleigh, NC: North Carolina State University, College of Forest Resources: 100-120.

Cooperative

Hansen, B.; West, C.; Engle, C. 1995. Fiscal year 1993 pallet industry ratio report. Arlington, VA: National Wooden Pallet and Container Association. 27.

(Work performed under a Memorandum of Understanding with the National Wooden Pallet and Container Association.)

Attainment

The hardwood industry is made up of a diverse array of small businesses. In order to remain both financially healthy and competitive, this industry must have access to current business and market statistics–including financial information. Financial ratios reveal much about the operation and health of a business. A financial ratio assessment was conducted in cooperation with the National Wooden Pallet and Container Association. Twenty vital industry ratios were derived on the basis of regional location, firm size, and product type. Overall the industry had a return on sales of 2.5%, return on assets of 9%, and return on equity of nearly 22%. The industry maintained an inventory equivalent to 25 days. Average collection on accounts receivable was 31 days. Employee turnover averaged 1.4. This study also identified key revenue sources for the industry: new pallet sales, 64%; used rebuilt, recycled pallets, 11%; lumber and by-product sales, 14.5%. In addition, a user friendly computer based tool and guide was developed for use by any business or industry. This program allows a user to quickly develop key financial ratios from information available on year end tax forms filed with the IRS.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4805

Enhancing the Performance and Competitiveness of the U.S. Hardwood Industry

Luppold, William G., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. An Analysis of the Structure, Conduct, and Performance of the Various Hardwood Product	RAR	74	.6	5		
2. Alternative Intervention Approaches to Remedy Externalities from Production/Processing Timber	RAR	36	.3			
3. Explore Strategies That Help Hardwood Processing Firms and Industries to Remain Competitive	RAR	12	.1			

Problem 1 **An Analysis of the Structure, Conduct, and Performance of the Various Hardwood Product**
FY 95 Research Attainments

Publications

Research Unit

Luppold, William. 1995. Effect of the hardwood resource on the sawmill industry in the central and Appalachian regions. In: Gottschalk, Kurt W.; Fosbroke, Sandra L.C., eds. Proceedings, 10th central hardwood forest conference; 1995 March 5-8; Morgantown, WV. Gen. Tech. Rep. NE-197. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 481-487.

Luppold, William G. 1995. The eastern hardwood sawmill industry, part 1. Timberline. 1(7): 22-23.

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Luppold, William G. 1995. Changes in the West Virginia, Virginia, and North Carolina hardwood sawmill industry. In: Proceedings, Appalachian Society of American Foresters 74th annual meeting; 1995 January 25-27; Winston Salem, NC. Raleigh, NC: North Carolina State University:

Luppold, William G.; Baumgras, John E. 1995. Relationship among sawlog price trends, species, and quality. National Hardwood Magazine. 69(8).

Attainment

The hardwood sawmill industry is the largest user of hardwood sawtimber in the United States. Over the last two decades, hardwood lumber production has increased by nearly 50%, while the number of sawmills has decreased. Increased mill size can be attributed to new technology, increased economies of scale, and the increasing density of the eastern hardwood resource. Increased timber density has lowered procurement cost by increasing the amount of timber in finite areas. Regional differences in procurement costs have caused considerable region variation in hardwood sawmill size. Sawmills located in the southern region are larger than mills in other regions because of relatively ample timber supply and flat terrain reduces procurement costs. Sawmills located in the midwest tend to be smaller because timber in this region tends to be spread out in smaller woodlots. Changing domestic and international markets combined with changing kiln drying technology have allowed hardwood sawmills to dry more lumber on site rather than to ship green lumber to secondary processors. This increase in mill site dry kilns also has allowed for more "value added" secondary manufacturing at sites proximate to hardwood sawmills and has increased rural employment in secondary forest products industries.

Problem 2 Alternative Intervention Approaches to Remedy Externalities from Production/Processing Timber
FY 95 Research Attainments

Publications

none

Attainment

Preliminary research in this area began the second half of FY 1994. No current attainment to report.

Problem 3 **Explore Strategies That Help Hardwood Processing Firms and Industries to Remain Competitive**
FY 95 Research Attainments

Publications

none

Attainment

Preliminary research in this area began the second half of FY 1994. No current attainment to report.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4951

Human Dimensions of Tourism, Fish, Wildlife, and Outdoor Recreation
Echelberger, Herbert E., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Forest recreation/tourism's role in quality of life and economic stability in rural communities	RAR	146	1.0	3		
2. Interactions between economic, psychological, and social dimensions of ecosystem management	RAR	110	1.0	1		
3. Ecosystem management for high-quality recreation and site access	RAR	110	1.0		1	

Problem 1 **Forest recreation/tourism's role in quality of life and economic stability in rural communities**
FY 95 Research Attainments

Publications

Research Unit

Daigle, John Joseph. 1995. Questions for and answers from Theresa S. Hoffman. Women in Natural Resources. 16 (4): 13-16.

Echelberger, Herbert E.; Dziekan, Kelly; Smith, Maja. 1995. Sustainable recreation on Lake Champlain. In: Linn, Robert M., ed. Sustainable society and protected areas: contributed papers of the 8th conference on research and resource management in parks and on public lands; 1995 April 17-21; Portland, OR. Hancock, MI: The George Wright Society: 27-35.

Glass, Ronald J.; More, Thomas A.; Echelberger, Herbert E. 1995. Natural resources and the quality of life in rural New England. In: Managing forests to meet people's needs: proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 September 18-22; Anchorage, AK. Bethesda, MD: Society of American Foresters: 327-328. Abstract.

Attainment

Information was provided to the Lake Champlain Conference, which is based in Vermont, on recreational resources of the Lake Champlain Basin, on current boating use on the lake, and on user opinions of pollution, conflicts, and other recreation-related issues associated with the lake and its use.

Problem 2 **Interactions between economic, psychological, and social dimensions of ecosystem management**
FY 95 Research Attainments

Publications

Research Unit

Glass, Ronald J.; More, Thomas A.; Zwick, Rodney. 1995. Human relationships with wildlife in Vermont. In: Vander Stoep, Gail A., comp. ed. Proceedings of the 1994 northeastern recreation research symposium; 1994 April 10-12; Saratoga Springs, NY. Gen. Tech. Rep. NE-198. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 47-50.

Attainment

Information was provided to Vermont state legislators and wildlife management agencies explaining how differences between special interest groups and the general public, regarding wildlife management issues, contribute to problems in writing legislation and implementing it.

Problem 3 **Ecosystem management for high-quality recreation and site access**
FY 95 Research Attainments

Publications

Extramural

Vander Stoep, Gail, comp. ed. 1995. Proceedings of the 1994 northeastern recreation research symposium. Gen. Tech. Rep. NE-198. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 264.

(Thomas A. More (NE-4951) served on the NERR Steering Committee in setting up the symposium, and participated in the editing and publishing of the proceedings.)

Attainment

Traditional economic valuation of natural resources fails to account for all the values people assign to them. Nonmarket values are more important than traditional economic values in some cases. Current research is exploring the role that people assign to nonmarket values of natural resources.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4952

Structure and Function of Urban Forests
Rowntree, Rowan A., Project Leader

FY 95 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Understand How Presettlement Forest Structure and Function is Changing as a Result of Urbanization	RAR	452	2.5	6		5
2. Understand Changes in Energy, Water, and Pollutant Flux Associated with Land Use Changes	RAR	574	2.5	3	2	5

Problem 1 **Understand How Presettlement Forest Structure and Function is Changing as a Result of Urbanization**
FY 95 Research Attainments

Publications

Research Unit

Pouyat, R.V. 1995. Review of "Urban nature magazine (volume 1)." Journal of Environmental Quality. 24(4): 794-795.

(Book review.)

Pouyat, R.V.; Turechek, W. 1994. N-mineralization and nitrification rates in forest soils along an urban-rural land use gradient. Agronomy Abstracts. 86: 388. Abstract.

(Presentation abstract. No proceedings.)

Pouyat, Richard V.; Carreiro, M.M.; McDonnell, M.J.; Pickett, S.T.A.; Groffman, P.M.; Parmelee, Robert W. 1995. Carbon and nitrogen dynamics in oak stands along an urban-rural gradient. In: McFee, William W.; Kelly, J. Michael, comps., eds. Carbon forms and functions in forest soils. Madison, WI: Soil Science Society of America: 569-587.

Pouyat, Richard V.; McDonnell, Mark J.; Pickett, S.T.A. 1995. Soil characteristics of oak stands along an urban-rural land-use gradient. Journal of Environmental Quality. 24 (3): 516-526.

Sisinni, Susan M.; Emmerich, Anthony. 1995. Methodologies, results, and applications of natural resource assessments in New York City. Natural Areas Journal. 15 (2): 175-188.

Zipperer, Wayne C.; Pouyat, Richard V. 1995. Urban and suburban woodlands: a changing forest system. The Public Garden. 10 (3): 18-20.

Cooperative

Goldman, Meadow B.; Groffman, Peter M.; Pouyat, Richard V.; McDonnell, Mark J.; Pickett, Steward T.A. 1995. CH4 uptake and N availability in forest soils along an urban to rural gradient. Soil Biology and Biochemistry. 27 (3): 281-286.

Groffman, Peter M.; Pouyat, Richard V.; McDonnell, Mark J.; Pickett, Steward T.A.; Zipperer, Wayne C. 1995. Carbon pools and trace gas fluxes in urban forest soils. In: Lal, R.; Kimble, John; Levine, Elissa; Stewart, B.A., comps., eds. Advances in soil science: soil management and greenhouse effect. Boca Raton, FL: CRC Press: 147-158.

McDonnell, M.J.; Pickett, S.T.A.; Pouyat, R.V.; Parmelee, R.W.; Carreiro, M.M.; Groffman, P.M. 1995. Ecological processes along urban-to-rural gradients. In: The transdisciplinary nature of ecology: program and abstracts: part two: abstracts of the 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to Bulletin of the Ecological Society of America. 76(2): 175-176. Abstract.

(Presentation abstract. No proceedings.)

Nilon, Charles H.; Long, Clayton N.; Zipperer, Wayne C. 1995. Effects of wildland development on forest bird communities. Landscape and Urban Planning. 32 (2): 81-92.

Templer, P.H.; Pouyat, R.V.; Eviner, V.T. 1995. Uptake of NO3 and NH4 by Acer platanoides, norway maple, and Quercus rubra, red oak seedlings. In: The transdisciplinary nature of ecology: program and abstracts: part three: additional abstracts and author index of 80th annual meeting of the Ecological Society of America; 1995 July 30-August 3; Snowbird, UT. Supplement to Bulletin of the Ecological Society of America. 76(3): 393. Abstract.

(Presentation abstract. No proceedings.)

Attainment

Progress was made for each of the research objectives in Problem 1. Research along an urban-rural gradient focused on changes in ecosystem structure and function. Within the urban component, higher rates of N-mineralization and decomposition were observed. Further, litter quality studies revealed higher recalcitrant litter and lower labile C. Analysis of trace gases showed lower rates of methane consumption in urban forest stands. The differences in C and N were attributed to differences in earthworm activities. These alterations of urban forest soil processes may affect forest health and productivity and require new approaches to forest restoration and rehabilitation. Management recommendations were developed for primary and secondary home construction in urbanizing wildland landscapes to minimize impacts on neo-tropical birds. Analyses indicated that cluster patterns may be the best method to minimize disturbances on the populations. In addition, methodologies were developed to inventory and assess urban forest parklands. Progress was made in understanding the relationship of vegetation structure to fire behavior along the urban-wildland gradient.

Problem 2 **Understand Changes in Energy, Water, and Pollutant Flux Associated with Land Use Changes**
FY 95 Research Attainments

Publications

Research Unit

Heisler, Gordon M.; Grant, Richard H.; Yang, Xiusheng. 1995. Climatology of ultraviolet radiation in urban environments. In: Abstracts of 91st annual meeting of Association of American Geographers; 1995 March 14-18; Chicago, IL. Washington, DC: Association of American Geographers:. 126. Abstract.

(Presentation abstract. No proceedings.)

Nowak, David J. 1995. Urban trees and air quality. In: Korpilahti, Eeva; Salonen, Tommi; Oja, Seppo, eds. Caring for the forest: research in a changing world: abstracts of invited papers: IUFRO XX World Congress; 1995 August 6-12; Tampere, Finland. [Place of publication unknown]: Finnish IUFRO World Congress Organizing Committee: 476-477. Abstract.

(Presentation abstract. No proceedings.)

Sisinni, Susan M.; Zipperer, Wayne C.; Pleninger, Andrew G. 1995. Impacts from a major ice storm: street-tree damage in Rochester, New York. Journal of Arboriculture. 21 (3): 156-167.

Cooperative

Abdollahi, K.K.; Nowak, D.J.; Ning, Z.H. 1995. Quantifying ozone removal capacity of urban tree species using a controlled gas exchange system. In: Managing forests to meet peoples' needs: proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 Septemer 18-22; Anchorage, AK. SAF Publ. 95-02. Bethesda, MD: Society of American Foresters: 538-541.

Abdollahi, Kamran K.; Nowak, David J.; Ning, Zhu Hua. 1995. Quantifying ozone removal capacity of selected urban tree species. In: Managing forests to meet peoples' needs: proceedings of the 1994 Society of American Foresters/Canadian Institute of Forestry convention; 1994 September 18-22; Anchorage, AK. SAF Publ. 95-02. Bethesda, MD: Society of American Foresters: 535. Abstract.

(Poster.)

King, Thomas S.; Grimmond, C.S.B.; Nowak, David J. 1995. Eddy correlation determination of local-scale energy and pollutant fluxes in Chicago. In: Abstracts of 91st annual meeting of Association of American Geographers; 1995 March 14-18; Chicago, IL. Washington, DC: Association of American Geographers: 156. Abstract.

(Presentation abstract. No proceedings.)

McPherson, E. Gregory; Rowntree, Rowan A.; Wagar, J. Alan. 1995. Energy-efficient landscapes. In: Bradley, Gordon A., comp., ed. Urban forest landscapes: integrating multidisciplinary perspectives. Seattle, WA: University of Washington Press: 150-160.

Yang, Xiusheng; Heisler, Gordon M.; Montgomery, Michael E.; Sullivan, Joseph H.; Whereat, Edward B.; Miller, David R. 1995. Radiative properties of hardwood leaves to ultraviolet irradiation. International Journal of Biometeorology. 38: 60-66.

Extramural

Demanes, Mark D. 1995. Surface and atmospheric controls on local-scale energy balance fluxes for Chicago and Sacramento. Bloomington, IN: Indiana University. 179. M.S. thesis.

(Unit partially funded student's research.)

Grimmond, C.S.B.; Oke, T.R. 1995. Comparison of heat fluxes from summertime observations in the suburbs of four North American cities. Journal of Applied Meteorology. 34 (4): 873-889.

(Unit partially funded this research.)

Attainment

Progress was made for each research objective in Problem 2. A major ice storm in Rochester, NY provided the opportunity to determine how different species and different sizes of trees responded to an ice storm. These data in conjunction with results on air pollution reveal how a city's air quality may be impacted my major storms. Analyses of sensible, latent and net storage heat fluxes as well as horizontal heat advection revealed similar diurnal patterns regardless of structural morphology and city location. However, day to day variation was considerable. Flux values were verified for parameterization in modeling activities. Sensible and latent heat fluxes were measured using eddy correlation techniques and combined with surface morphology database in a GIS. The analysis examined the relationship between the fluxes and surface morphology. Advances were also made on the effect of urban tree species on reflectance, transmittance, and absorptance of ultraviolet-A and B radiation. Results showed high degree of absorptance by all species but high variation in reflectance; however, reflectance was relatively low (1-9%). A methodology was developed to quantify ozone removal capacity on urban trees. This information was used to develop guidelines in selecting tree species for ozone removal and mitigation.

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